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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

Institution of British Foundrymen.
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Co-operation in Research.

The tendency for research to be a monopoly of the academician, or the physical chemist, cannot have failed to be noticed by all progressive foundrymen. This state of affairs is due primarily to his special training, and secondarily to the precision apparati at his disposal. It does not follow that the results obtained from this class of work are of more value to the trades concerned than those given by the technical or even the practical man, because the highly-finished work of the research student is often a statement of facts, the propounders of which do not know or at least are afraid of giving their practical application. This was dealt with last week at the Swansea meeting of the Institute of Metals, by Sir Henry Fowler, who pleaded on behalf of the practical man to the newer schools of professors to indicate clearly the data capable of being translated by the departmental manager into actual practice. If a paper is without any practical interpretation then it might be so stated, so that the practical men associated with the various institutions can better occupy themselves than by listening to a discussion from which there is little change of their deriving any benefit beyond a lesson in the art of mutual congratulation. If real benefit is to be obtained by owners and managers from spending several days away from their works, then the councils of the various technical (not the academical) societies should insist that the practical bearing of the papers must be clearly emphasised, or if the high-brows insist on arguing abstruse points, then perhaps it would be well to follow the American system and hold simultaneous meetings, so that those in charge of manufacturing processes will have a chance of eliciting and giving information helpful to the work in hand, and not something which might be useful in ten years' time. At this period, perhaps, it may be found that the research worker has so come down to earth that he is capable of successfully controlling manufacturing processes. At the moment, however, manufacturers prefer to employ technical men—men who should be capable of economically utilising the results of published and his own research work through the medium of his foreman, skilled men and labourers.

In some sections of the metallurgical industries well-informed departmental managers are hesitating to give papers or contribute to discussions because of their lack of training in the higher branches of modern physics, and fear the criticism of those so versed. We can assure them that it is the absence of practical knowledge which restrains the research worker from hazarding any application of his work to practice. Therefore the timidity is mutual.

The foundry trades can congratulate themselves that of all societies their representative technical association is the best in so far as catering for the actual workers is concerned, for when highly-scientific papers have been presented, the lecturers have been careful to point out the practical bearing.

No doubt, in the future, the Institution of British Foundrymen will accept a limited number of academical contributions, but we believe that before their advent a number of educational papers which have been and will be presented, will overcome the objection sometimes raised by the research worker that "It is not our fault if managers are sufficiently educated to understand our investigations." Speaking for the foundry end of the metallurgical industries, we feel sure that the intensive application of old-fashioned elementary chemistry, physics, and mathematics will do infinitely more good than any wild-cat chase into the realms of their higher branches.

Electric Furnace Developments.

Mr. Frank Hodson, president of the Electric Furnace Construction Company, of 908, Chestnut Street, Philadelphia, Pa., and until lately also associated with Messrs. T. H. Watson & Company, of Lancaster Street, Sheffield, recently sailed for the States.

During his visit to Europe he negotiated the representation of the Grönwall electric high furnace for many parts of the world. His firm are busy with the construction of 100-ton electric furnace for the Ford Motor-car Works. It is to be based on the Greaves-Etchell system, and will carry eight 12-in. graphite electrodes. It is to be used for refining only—not for melting.

The Institute of Metals.

AUTUMN MEETING AT SWANSEA.

The autumn meeting of the Institute of Metals was held in the Llewellyn Hall of the Y.M.C.A. from Tuesday, September 19, to Friday, September 22, under the Presidency of Mr. Leonard Sumner, O.B.E., M.Sc.

First Day.

The first annual lecture on subjects of practical interest to those engaged in the non-ferrous metals industry was delivered in the evening by DR. R. S. HUTTON (Member of Council), the subject being: "The Science of Human Effort (Motion Study and Vocational Training)."

Second Day.

The general meeting of members was opened in the Llewellyn Hall of the Y.M.C.A., the President (Mr. Leonard Sumner) occupying the chair.

Civic Welcome.

THE MAYOR OF SWANSEA (Alderman William Owen, J.P.) said that on behalf of the Aldermen, Councillors and Burgesses of Swansea he extended a most hearty and cordial welcome to the members of the Institute. Swansea was an old town of great importance, its prominence being largely due to the industries and trades in which it was engaged. The metallurgical trades of the country and the industries concerned with them, copper smelting in particular, had placed Swansea in the proud position of being the greatest metallurgical centre in the world. That statement might be challenged, but nevertheless it was true. The Vivian family were the early pioneers of the metallurgical trade of the port of Swansea. The ores at that time chiefly came from Cornwall, but the demand was so great that they recognised, in a very short time, that Cornwall alone could not supply the ores required. With the opening up of the Chilian and South American trade Swansea began to develop very rapidly indeed. Swansea had also made great progress in a scientific direction. The system of education in Swansea at the present time lent itself in every respect to the further development of the trade which had done so much for the town. Swansea possessed a very fine elementary system of education; it also possessed a Technical College, a School of Art, and last, but not least, the University College. During the visit which the members would pay to the University College they would have the opportunity of seeing some of the most efficient and up-to-date laboratories in the country, under the distinguished control of Professor Edwards.

DR. T. FRANKLIN SIBLY (Principal, University College of Swansea), in voicing the welcome of the educational authorities of the town, said he very much regretted to state that owing to an important business engagement Mr. Gilbertson, the President of the University College, was unable to be present to receive the members.

MR. H. LANG-COATH (Town Clerk) also added a few words of welcome to the members.

THE PRESIDENT thanked the Mayor, Dr. Sibly, and the Town Clerk for the very cordial and hearty welcome that had been extended to the members on behalf of the Borough of Swansea. He thought the Mayor was quite right in claiming that Swansea was the biggest metallurgical centre in the world. He made that remark with all due deference to the gentlemen who came from Birmingham and elsewhere. Modern non-ferrous metallurgy was founded by the Vivian family somewhere about 80 years ago Swansea was a most important centre, its industries comprising copper, nickel, silver, gold, spelter, and tinplates, the latter of which he thought might be claimed as a part of the non-ferrous industry. He thanked the Mayor for sparing a few minutes of his valuable time to attend the meeting, and for the cordial and hearty reception that he had given to the members.

Nomination of Officers.

The minutes of the last general meeting were taken as read, and confirmed.

THE SECRETARY announced that as a result of the ballots that were held in July and September the following 37 members and 15 students were found to be duly elected.

THE SECRETARY read the following list of Council nominations for the offices for 1923:—

President: Mr. Leonard Sumner. Vice-President: Mr. W. Murray Morrison (new nomination), Sir Thomas Rose, retiring vice-president, who was eligible for re-election.

Members of Council (six vacancies): Mr. T. Bolton and Mr. G. A. Boeddiker (new nominations), Engineer Vice-Admiral Sir R. B. Dixon, Professor C. A. Edwards, Mr. S. Everett and Mr. H. B. Weeks (retiring members, who offer themselves for re-election).

THE PRESIDENT announced that the result of the ballot would be declared at the annual general meeting, to be held on March 7 and 8, 1923. According to the articles, Section III. (16) in ten numbers might also at that meeting nominate a candidate other than the ones just nominated by the Council.

Sixth Report to the Corrosion Research Committee.

BY GUY D. BENGOUGH AND J. M. STUART.

The aim of this Report is to present a general discussion of corrosion phenomena, based on the study of several different metals, and to examine how far the electro-chemical theory of corrosion (usually called the electrolytic theory) can account for the observed phenomena. The difficulties encountered by this theory are indicated, and it is shown that it gives a satisfactory account of the facts only under certain conditions, while many facts can only be explained by recognising the important part played by colloids in corrosion. A theory of the mechanism of colloid action is put forward, and some experimental results are reviewed in the light of this theory.

As regards the effect of impurities on the corrosion of metals a trace of impurity appears to assist local corrosion, but the amount of corrosion is not proportional to the amount of impurity. Even the presence of graphite does not appreciably stimulate the rate of corrosion of iron. The effect of a trace of impurity is probably a trigger action.

On the electro-chemical theory the action of oxygen is that of a depolariser. It can be shown, however, that atmospheric oxygen has very little depolarising power at ordinary temperatures. The main function of oxygen in corrosion is to oxidise directly the metal, and also in some cases the products of corrosion.

Two chief types of corrosion are distinguished: (1) The general type, usually characteristic of acid corrosion; (2) the local type, usually characteristic of corrosion in water and salt solutions. The second type is generally characterised by the formation of an adherent scale on the metal, and this scale may contain colloid.

Discussion.

PROFESSOR H. C. H. CARPENTER, in opening the discussion, said that since the work of the Committee was inaugurated 11 years ago, it had followed two main directions; on the one hand, the strictly practical problem of determining the causes of corrosion on marine condenser tubes, and, on the other hand, the elucidation of the broad aspects of corrosion itself. In the early days the former problem was the one chiefly attacked, and the first three reports dealt mainly with that aspect of corrosion phenomena. In the Fourth Report, however, the members received the first real indication that it was necessary to go outside the study of that particular problem, and to ascertain more fundamentally what corrosion really was. In the Fifth Report a return was made to the practical aspects of the question, and following upon that a pamphlet was published at

the last meeting of the Institute, which presented in compact form the results of all previous work. He also desired to say that the Committee had been very much encouraged by the increase in the contribution which was paid to the Institute by the Brass and Copper Pipe Association, which had increased its contribution from £300 a year to £500 a year.

Moreover, they had the satisfaction of knowing that the Department of Scientific and Industrial Research, which gave a large grant towards the work, really gave their aid to investigations of a fundamental character with the greatest pleasure. It might therefore be said that a stage had now been reached when the value of the work was becoming more and more widely recognised, and a position had now been reached where they had, so to speak, touched bottom. It was impossible to have anything more fundamental than the present Paper. To what extent it would survive the work of future investigators only the future could show, but at any rate Dr. Bengough and his collaborators had led the members to the point which fundamentally required investigation. The authors indicated that no metal was really inoxidisable, and that the number of things which could happen to the inside film was very considerable, so that it might be wondered whether after all the problem would ever be solved. If that was the impression which the Paper gave, he would like to say, for what it might be worth, that he did not share the view which was held that a solution of that particular problem would not be reached.

In conclusion, he desired to say that he thought the Report under discussion would prove to be the most important Paper that had yet been published under the auspices of the Institute. But he also thought it would be some time before its full effect was felt. That was the test as a rule of a good piece of work, and although he was not inclined to prophesy to any extent, but really thought that the experimental data in the Report and the presentation of the authors' views would ultimately become a classical contribution to the phenomena of corrosion.

Electro-Chemical Theory Advanced.

MR. U. R. EVANS expressed satisfaction that the authors of the report laid stress on the physical character of the corrosion product in determining the persistence of corrosion. The oxide coat that generally existed upon aluminium was almost as good a protective covering as a layer of nickel or silver, but in other cases the corrosion product was non-adherent, and afforded no protection. Certain reagents, notably chlorides, tended to loosen the products and prevented it from shielding the metal effectively. Their action seemed to be governed by the same universal physical principles as the action of soap in removing a grease film from metal. Everyone knew that it was difficult to remove a grease film by rubbing with pure water, since the removal of the grease from the inter-face into the water would involve an increase of the inter-facial energy of the system, and this had to be provided as the mechanical energy of scrubbing. If, however, the soap was added to the water the case was different; the inter-facial energy at the boundary between grease and soap solution was small, and the removal of the grease from the surface in small globules into the soap solution involved no increase of energy, and proceeded quite easily. Similarly, the oxide film existing on many metals was closely adherent when they were immersed in pure water, but if chlorides were added to the water the separation of the oxide from the metal involved no increase of inter-facial energy, and the corrosion product tended to be of a loose character. Hence the importance of chlorides in preventing the passivity of metals. It was noteworthy that those metals which, like iron or nickel, had oxide soluble in acid and insoluble in alkali, tended to become active in the presence of acid and passive in the presence of alkali. Metals, like tungsten or molybdenum, which had oxide soluble in alkali, but almost insoluble in acid, tended to become passive in an acid solution, but were rendered active in an alkaline solution. Turning to the question of whether corrosion was chemical or electro-chemical, it would appear that since the atoms were certainly electrically charged in the combined state, corrosion was essentially a passage from the uncharged to the charged condition, and consequently an electrical factor must be involved; in this sense, even the so-called "direct chemical attack" was really electrical. The type of electro-chemical corrosion which was associated with the production of distinct anodic and cathodic areas was, however, another matter, and it was a question still requiring experimental investigation. The difference between this electro-chemical corrosion and direct-chemical corrosion was that in the direct-chemical type the metal would only be attacked at those points to which the oxidising agent, usually dissolves oxygen had direct access; in the electro-chemical type corrosion might occur at places to which the oxidising agent had no access. It was clear, however, that corrosion often proceeded most rapidly at those points to which the dissolved oxygen had least access, as for example, at the bottom of pits or where the metal was shielded by string, cotton wool, wax or permeable corrosion products. None of the chemical theories of pitting explained how the oxygen was at the bottom of a deep pit, whereas if corrosion was attributed to a difference of potential between the aerated and unaerated portions, it could be said that the metal entered the ionic state at the unaerated portion within the pit, forcing out upon the parts of the surface outside the pit, hydrogen which was removed by the oxygen there present. There was another line of argument which lead in a logical manner to the conclusion that much of the corrosion met with in practice and which the authors attributed mainly to chemical action, was to a great extent of the electro-chemical type. He was surprised that they laid so much stress upon the fact that the hydrogen produced by the action of water upon zinc was invisible even under the microscope.

It would be asked why oxygen should diffuse towards commercial spelter quicker than towards Brunner-Mond zinc, or why it should diffuse quicker towards cast than wrought iron. Of course, in certain specially-made material, such as Lambert's iron, the uniformity must be such that the hydrogen was not produced so quickly as it was used up, but such materials were quite exceptional, and could not be obtained without taking special precautions. It seemed clear, therefore, that the rate of corrosion where oxygen was present was largely independent of the purity of the material and of the conductivity of the solution. The different behaviour of the different metals was dictated not so much by their position in the potential series as by the solubility and physical character of the corrosion product under the conditions in question. The action of non-oxidising acids upon reactive metals was however governed by quite different laws, because here the hydrogen was evolved in bubbles, and the question of oxygen diffusing did not enter in. Accordingly, in dilute hydrochloric or sulphuric acid, cast-iron dissolved more quickly than the so-called open-hearth pure iron. The dissolution of metals in acid was much more rapid than in neutral solution, and accorded rather better with the position of the metals in the potential series, but there was still one complicating factor, namely, that remarkable super-saturation phenomenon which was known to electro-chemists as over-voltage.

Over-Voltage.

Pure zinc was hardly ever attacked by acids owing to its high over-voltage, but certain impurities, and especially metals which were more noble than zinc, and which had low over-voltage values had a remarkable accelerating action. Of course, they could only act as cathodic areas when present as a separate phase. If uniformly distributed in solid solution, they had no immediate influence. But all the noble impurities in zinc, whether present in solid solution or between the grains, appeared as a black scum on the surface of the metal as attack proceeded. This gave an explanation of the so-called period of induction observed in the corrosion of zinc. When zinc was first immersed in acid the attack was slow, but as the black scum, consisting mainly of lead and cadium, appeared on the surface dissolution proceeded faster and faster. It was found that if the black scum was removed the rate of attack dropped again, a fresh period of induction being observed.

It would seem, therefore, that the difficulties raised by the authors of the report largely disappeared when the matter was closely investigated. The authors gave a number of cases which they stated was difficult or impossible of explanation on the electro-chemical theory, but it appeared to him that in none of those cases was an electro-chemical interpretation definitely excluded. There was not time to discuss them in detail, and further work was required to decide the relative importance of chemical and electro-chemical corrosion.

Nomenclature Requires Simplification.

MR. W. H. J. VERNON said that his main object in entering the discussion was to put in a plea for the simplification of corrosion nomenclature, the need for which no one familiar with corrosion literature would dispute. Excluding for the moment considerations of colloidal phenomena, it might fairly safely be said that the alternatives in regard to initial action in aqueous solutions boiled down to two only. Either the metal passed into solution in the ionic condition in virtue of its electrolytic solution tension, or the surface of the metal was attacked by molecular oxygen already present in solution. These two cases were exemplified in the report, and the behaviour of the corrosion products as indicated in the text followed readily from considerations of their mode of formation. To his mind it seemed highly desirable that the scheme of nomenclature should clearly differentiate between these two fundamental types of initial action, and he confessed to that in the present connection this was all that appeared necessary to do. The authors had got the latter type safely fixed up, this constituting the direct oxidation dealt with in the fourth report. The term "electrolytic" was in very common use, and, personally, he could see no objection to applying this term to any case where a metal passed into solution ionically, *i.e.*, in virtue of its solution tension. This suggestion would get rid of such terms as "acid theory," "carbon dioxide theory," etc., with which, unfortunately, the literature of the subject abounded. These terms were frequently misleading, and at the best were merely redundant, and he thought the time had come when a serious attempt should be made to do away with them.

Corrosion of Boats.

Referring to the particular case of electrolytic action where there were definite anodes and cathodes, which admittedly was the usual state of affairs where continuous corrosion was proceeding, the term "galvanic couple" was available. This term was in common use by chemical authorities, and for the present purpose seemed preferable to the term "electro chemical," since the latter was very frequently used synonymously with electrolytic. The galvanic couple type of electrolytic action for the purpose of emphasising its importance in corrosion phenomena. While this action naturally flourished most in acid liquids, it occurred quite frequently in neutral solutions. As an example of internal or local surface action it might be mentioned that certain alloys of zinc with tin and copper corroded rapidly in distilled water, and it might readily be arranged for the displaced hydrogen to be collected. With regard to the external type of couple action, very many examples could be quoted from practice. Some years ago legal action was taken over the wholesale damage due to iron ships in Leghorn Harbour through the presence of copper-bottomed yachts, electrical connection being afforded through hausers and buoys. The electrolytic theory was then vindicated to the extent that the copper-bottomed vessels had to be removed from the harbour. Coming to more recent times, a case was described only last year before the American Electro-Chemical society of a schooner cased with plates of monel metal. Contact of this metal with the steel rudder-frame and other exposed steel parts took place, which resulted in their rapid corrosion—so rapid, indeed, that the ship was broken up without having made a single voyage.

Author's Reply.

MR. J. M. STUART, in reply, thanked Professor Carpenter for the kind remarks he had made on what the authors considered was a somewhat speculative Paper. He had been greatly interested in Mr. Evans's defence of the electro-chemical theory. One point, however, which Mr. Evans passed over, which had always puzzled him in connection with that theory, was how the pacifying effect of dichromates could be explained. With regard to Mr. Vernon's criticism, they did not deny that electro-chemical oxidation could take place in neutral solution, but in cases where it did occur in neutral solutions the voltage between the two elements was quite considerable, and the two elements which were corroding, corroded quite differently from corrosion which occurred when they were separated. He proposed to leave Dr. Bengough to deal with the remainder of the points that Mr. Evans had raised.

THE PRESIDENT said that owing to the shortness of time available he proposed to ask Dr. Bengough to put his reply in writing. In proposing a hearty vote of thanks to the authors for their very interesting Paper, he wished to say that when he first tried to read the Paper his heart sank, because he thought a new conclusion was arrived at by the authors. The members of the Institute wanted to find out why condenser tubes corroded, and he thought when he read the Paper that they were as far off from anything as they ever were.

The Effect of Superheated Steam on Non-ferrous Metals used in Locomotives.

BY SIR HENRY FOWLER.

Superheated steam is now generally used on locomotives, the steam usually leaving the superheater at a temperature of 340 deg. C. Not all the parts mentioned are subjected to this continuously as the steam expands, and in so doing falls in temperature. The practice referred to is that adopted on the Midland Railway. The parts dealt with are:—(1) Piston tail rod bushes, (2) piston rod packing, (3) piston valve fittings, (4) cylinder relief valves and (5) by-pass valves.

THE PRESIDENT said that although none of the members present seemed desirous of discussing Sir Henry Fowler's Paper, he hoped that some of them would send in written communications on the subject. In the meantime he proposed that a hearty vote of thanks be accorded to Sir Henry Fowler for the trouble he had taken in preparing the Paper.

White Metals.

BY A. H. MUNDEY, C. C. BISSETT, AND J. CARTLAND.

An abstract of Part I. of this Paper dealing with bearing metals will be found on another page.

The Luxemburg Iron and Steel Industry in 1921.

The iron-ore exports declined from 2,042,889 tons in 1920 to 1,668,582 tons last year. Those to occupied Germany fell from 475,061 tons to 444,781 tons, to Germany itself from 827,602 tons to 698,998 tons, and to Belgium from 551,768 tons to 357,776 tons in the two years. On the other hand, the imports from France increased from 965,124 tons in 1920 to 1,054,447 tons last year.

With regard to the production of iron and steel, the report states that while the pig-iron output declined in neighbouring countries, it showed an increase in the Grand Duchy. The Luxemburg works took advantage of the facilities offered by the coke market to increase production, so as to reduce first costs and at the same time prevent unemployment. Out of the 47 furnaces, from 18 to 23 were in blast, as against from 17 to 19 in 1920, and the output was 970,336 tons of pig-iron, as compared with 692,935 tons in 1920. Of the 1921 output 79,223 tons were foundry pig-iron (62,204 in 1920), 890,438 tons were basis Bessemer pig (630,161 tons), and 675 tons forge pig (570 tons). The average price of the total output was 246.57 fcs. (say 98s. 6d.) per ton, as compared with 551.03 fcs. (say 220s.) in 1920.

The production of steel ingots at the seven steelworks in the country increased from 569,545 tons in 1920 to 750,974 tons last year, and the average price per ton declined from 755.37 fcs. (say 302s.) to 292.73 fcs. (say 117s.) in the two years respectively.

McConway Centrifugally Cast Steel.

One of the features of the recent Iron and Steel Institute meeting at York was a film demonstration in the Festival Concert Room on Tuesday afternoon by MR. WILLIAM MCCONWAY, of Pittsburgh, descriptive of the new McConway process for the production of steel discs by centrifugal and hydraulic methods direct from molten steel. Mr. McConway is the head of the well-known McConway and Torley Company, of Pittsburgh, U.S.A., who are perhaps best known in this country as the makers of the coupler for railway wagons which bears their name, and who operate steel foundries in connection with this and other specialities, and also have steelworks and rolling mills.

The principles of the McConway process, if they work out in practice with the economies which the inventor anticipates, will be just as revolutionary in the handling of steel from the molten condition to the finished product as were the Bessemer and Siemens processes in the production of liquid steel. The process has been evolved as a result of six years' experimental work, some of which was held up owing to the exigencies of war service, but has now reached the stage where it has been definitely proved successful so far as the practical difficulties of the process are concerned. Mr. McConway originally developed his process as an adjunct to his steel-foundry practice, *i.e.*, the steel cylinders were cast in ordinary sand moulds, and were afterwards further manipulated with a view to producing tyre blanks and thereafter tyres, turbine discs, and other products of a similar nature. It is not, of course, necessary to dwell upon the heavy loss in metal in the form of scrap which occurs in the production of a tyre by the present process of forging the "cheese," cutting out the centre, and thereafter rolling it to a tyre. The loss in the centrifugal process is about 5 per cent. only.

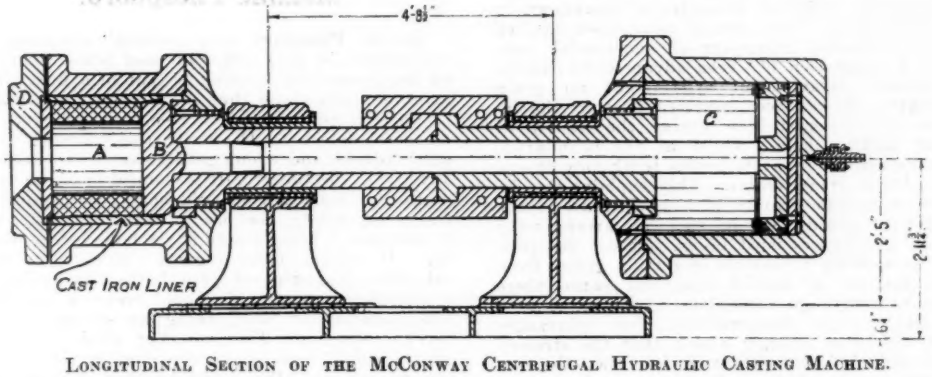
The chief claim of the McConway process for tyre blanks is the large saving in metal which it effects. Mr. McConway has, however, carried the process a step further, and claims to produce centrifugally cast rings which can thereafter be cut into standard billets, and these billets used for rolling merchant products. His view is that this process can be reduced to such a cost that it will be possible to produce even the cheapest forms of rolled steel, *i.e.*, ferro-concrete bars, from centrifugally cast billets, and it need hardly be said that if these views are borne out by further experience, the blooming mill will (in some lines) be a relic of the past, and much future steel practice will proceed direct from the centrifugally cast semi-product to the finishing mill.

The chief element of the McConway process is a centrifugal hydraulic casting machine, of which a section is shown herewith. It will be seen that this consists of a cylinder A, in which the castings are made, a piston B fitting into this cylinder, and a hydraulic cylinder C. The ingot metal from the furnace is tapped in the ordinary way into a ladle, which is brought to the machine, and the metal tapped through the runner into the casting cylinder A through the detachable casting head D. During the process of feeding the metal and casting, the machine is rapidly rotating, the peripheral speed in the casting cylinder being approximately 65 ft. a second. The effect is that the metal is immediately forced to the periphery of the cylinder, and forms a cylindrical or ring-shaped ingot.

The cylinder is fitted with a cast-iron liner, and the piston B is of steel with a cast-iron face, so that the whole cylinder against which the metal is cast is lined with cast iron, there being also a cast-iron liner on the detachable head. In the matrix at present in use the diameter of the cylinder inside the cast-iron liner is 30 in. In the forging-press operations, which follow next, this diameter is usually increased, say up to 38 in., or less if desired, the diameter of the central hole as required being the governing factor.

The length of the casting cylinder is 12 in. Immediately after the metal is poured into it the piston B is slowly advanced, and the cylinder of metal by this means is compressed during the cooling from its initial length of 12 in. to about 10½ in. The whole process takes from 15 to 17 minutes. Approximately two-thirds of this time is taken up with casting, centrifugalising and solidifying the cast, and the other third in removing it to the soaking pit.

Hydraulic End.—The other end of the press consists of an ordinary hydraulic cylinder, which through its piston and rod operates the casting cylinder piston. A feature, however, of the invention, and a mechanical contrivance which has rendered the process possible, is the stuffing box. The great difficulty arose in getting hydraulic pressure into a cylinder rotating at this speed. The solution was the stationary hydraulic pipe leading through the stuffing box on the outer end of the hydraulic cylinder and revolving in the pipe end, as on a nipple; orifice, 0.11-in. diameter. The usual water pressure is 500 lbs. per sq. in., but pressures up to 1,200 and 1,400 lbs. have been employed.



LONGITUDINAL SECTION OF THE MCCONWAY CENTRIFUGAL HYDRAULIC CASTING MACHINE.

We understand that this machine has given every satisfaction from a mechanical point of view in the casting of these centrifugal cylinders. Cast-iron liners have been found to be the most suitable material with which to line the casting cylinder, and owing to the shrinkage of cast steel of approximately ¼-in. to the foot, there is, of course, no difficulty about ejecting the cylindrical ingot of metal when cast.

After being ejected from the press, the ingot is taken to a soaking pit and then finished under an ordinary hydraulic press, one of 2,000 tons being at present used for this purpose. It is then still further forged as may be necessary.

It follows that in this centrifugal casting process the metal at the periphery of the ingot is exceedingly dense and free from slag inclusions. The slag, being lighter, concentrates in the inside circumference of the casting, and it has been found advantageous to broach the hole in the "cheese" just before the last pass in pressing. A very light cut will remove practically all the slag inclusions. The further treatment of the ingot, therefore, which has previously been kept in a soaking pit and brought again to a forging heat, includes this broaching of the centre core

The chief claim of the McConway process is, of course, the reduction in discard, which, as all steelmakers know, is a very large one when figured from ingot weight to weight of finished product, either in tyres, rails, or bars. The metal obtained is also very homogeneous and free from segregation and slag inclusions. Beyond this it is not claimed that the metal is stronger or more ductile, *i.e.*, bars produced from billets made in this way would average about the same in strength and ductility as bars made from ingots of the same composition in the ordinary way. Its application to low-priced products, such as merchant bars, involves questions of capital outlay which have not yet been fully examined. Mr. McConway, indeed, has not as yet made any decision as to how he proposes to deal with the process from the financial standpoint. The purpose of the exhibit given was mainly to acquaint the trade with what had been done mechanically in developing this new process.

The agents of the American firm are Messrs. W. Bayliss and Company, Limited, 240, Dashwood House, New Broad Street, London, E.C.2, through whom communications to Mr. McConway may be addressed.

Grain-size and Diffusion.*

By Professor J. H. Andrew and Robert Higgins.

Experiments have been conducted which show the relation between grain-growth and diffusion. Diffusion at high temperatures may take place simultaneously with grain-growth, whilst at low temperatures diffusion promotes a breakdown in the grain-size. These results have been applied to the annealing treatment of commercial castings. A suggestion has been advanced to explain the atomic arrangement existing at the grain boundary. It has been assumed that in the interior of the crystalline grains the system of closest packing holds, whilst at the boundaries, the atoms in the separate grains touch only at one part of the circumference. This explains the decrease in specific gravity with an increase in the number of grains, for in such an arrangement certain free spaces must occur. Plastic deformation, by shifting the atoms in certain grains from their position of equilibrium, will cause these atoms to rearrange themselves when heated to a sufficiently high temperature; this rearrangement will be so brought about, that the stressed atoms will fall in with, row for row, the unstrained atoms of the adjacent crystal, thereby effecting a gradual migration of the grain boundary. Such a rearrangement may proceed from every side of a crystalline unit, resulting in one grain being divided up and being absorbed by others. The final bounding surface will result when a state consistent with that suggested for the boundary configuration finally results. A suggestion based upon the Langmuir idea of valency has been given to explain the migration of a separating phase to the grain boundary.

The Structure of Eutectics.*

By F. L. Brady.

This Paper deals with the structures exhibited by eutectics, mainly those between metals and metallic compounds. An attempt has been made to correlate the microstructure of a solidified eutectic with the physical properties of the component metals. The surface tension of the molten metal and the cohesive force acting during crystallisation seem to be the main forces influencing the final structure. The eutectics examined, which include those between metals whose physical forces are known, fall quite decidedly into three classes. The terms "globular," "lamellar" and "angular" have been suggested as convenient terms for these divisions. The structures agree well with what would be expected from theoretical considerations of the effects of surface tension and cohesion. Photomicrographs are given of characteristic structures of the various alloys examined, and an account is given of the methods of polishing the alloys, and a list of the etching reagents found most suitable.

* Papers read at the Autumn Meeting of the Institute of Metals.

The Copper-rich Aluminium-copper Alloys.*

By D. Stockdale.

The structures of the alloys of copper with aluminium up to 20 per cent. of aluminium have been investigated by the author, who used the thermal data supplied by a study of the cooling-curves of the alloys and by quenching experiments in conjunction with microscopic examination in order to obtain the equilibrium diagram more exactly. He discredits the opinion that the addition of small quantities of aluminium to pure copper raises the freezing point of that metal, and shows that the minimum in the liquidus curve at 1031 deg. C. with 8.3 per cent. of aluminium is a true eutectic point. A small arrest point at 1017 deg. with alloys containing between 16.5 and 18 per cent. of aluminium has been discovered, but there is no indication of a minimum in the liquidus at about 16 per cent.

Copper, at 1000 deg. C., can hold only 7.4 per cent. of aluminium in solid solution; at 500 deg. C. and at lower temperatures it can hold 9.8 per cent., although to obtain such an alloy a long annealing is required. The beta solid solution breaks down above 535 deg. C., and Andrew's observations on the gamma and delta constituents have been confirmed. That portion of the diagram concerning the beta and gamma field has been radically altered.

* Paper read at the Autumn Meeting of the Institute of Metals.

"Metallic Phosphoro."

Metallic Phosphoro is a material admitting of application in both the iron and brass foundry. In the former its function is that of a flux. The manufacturers claim that it increases fluidity and produces a well-mixed iron free from porosity due to metal defects. Obviously those arising from sand troubles and wrong gating cannot be cured by any sort of deoxidiser. It is claimed to be specially useful for warming up cold heats, the manufacturers suggesting the use of 1 oz. per cwt., the "phosphoro" being placed in the ladle before teeming. If, as the name suggests, it contains considerable quantities of phosphorus, its oxidation to phosphorus pent-oxide would evolve a considerable quantity of heat, being an energetic exothermic reaction. The resultant oxide of phosphorus would rise up to the slag, having a low specific gravity. We doubt whether, unless used in excess, the phosphorus content of the mix would be increased. A further advantage claimed, which must be due to exothermic reaction, is the better incorporation of silicon as ferro-silicon. Unless an initial good heat is available, ferro-silicon can be difficult as regards its even dissemination throughout the metal, especially if lumps of too large a size are used. Powdered ferro-silicon is liable to rest on the slag.

Use in the Brass Foundry.

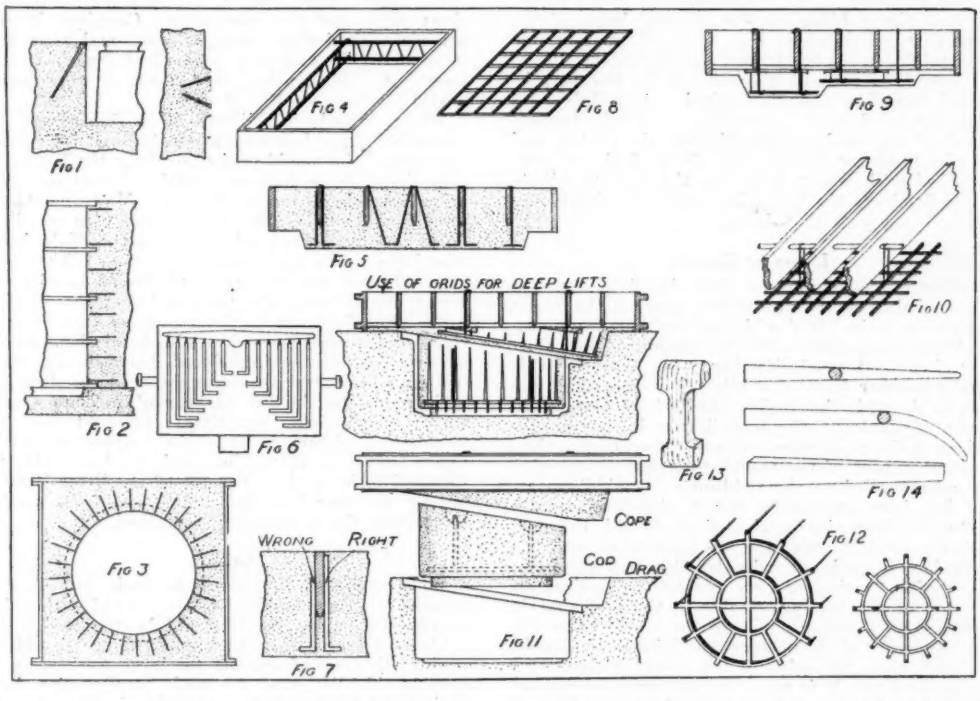
Metallic Phosphoro is claimed by the makers to increase density, fluidity, strength, and diminish shrinkage, sponginess, cold sheets and blow holes. As a partially substitute for tin in Government bronze or gun-metal, "metallic phosphoro" has, it is claimed, been pronounced by the United States Government as being specially successful. In a mixture containing 2 per cent. or less of tin, all the tin may be replaced by one-half of the amount thus omitted in "metallic phosphoro" and the remaining half in zinc. Thus, an alloy containing 70 per cent. Cn., 2 per cent. Sn., and 28 per cent. Zn. would be replaced by 70 per cent. Cn., 29 per cent. Zn., and 1 per cent. of the new alloy. As the material is already extensively used in the U.S.A., it should be worth the while of British founders to investigate. We hope in the near future to be able to give our readers more details of the chemical composition of the alloy, so that the more scientific foundrymen will be able to regulate its use without reference to the sellers. In this way the new alloy will have a better chance of finding a larger scope of utility. The British selling rights are in the hands of Mr. Charles Hall, 409, Newton Avenue, Milwaukee, Wisconsin, U.S.A.

An Apprenticeship Course in Foundry Practice.—XI.

By Ben Shaw and James Edgar.

RODDING AND THE USE OF GRIDS.

Sand moulds frequently require to be strengthened to enable them to maintain their shape and position before the rush and pressure of the metal, or to prevent them from collapsing under their own weight, or owing to a combination of these factors. While box bars fulfil this need to a considerable extent, it is not customary to make special boxes for a specific job unless the number of castings required is considerable when it becomes an economical proposition. It follows, therefore, that some arrangement must be made whereby available moulding boxes can be used for a variety of moulds within their capacity. Box bars can only be cast with boxes to accommodate the general run of work for which the box is to be used and when any part of the mould required to be moved with the box is not sufficiently supported by the bars other means must be employed. Deeper boxes can be used to cover a larger area than shallow boxes without the aid of bars, but it must only to support corners or projecting details, but in flat surfaces over which the metal is required to flow in order to prevent the action of the metal washing the surface sand out of position. These sprigs are just ordinary cut nails, either with or without heads, and they vary in length for general work from 2½ in. to 4½ in. They are distinct from what are known as steel moulders' nails, which are required to be cast with the metal, the latter having a bright finish. Although sprigs are especially useful in connection with green sand moulding, because the sand is comparatively weak, they are also effectively employed in dry sand and loam moulding. In green sand moulding they are often introduced during the process of ramming, but for strengthening the corners at joints or other places where the ramming is likely to displace them they are pushed into the sand when the ramming has been completed and before or after the pattern is withdrawn, as circumstances permit. It is important to use the sprigs in such a manner



be remembered that the mould must not only sustain its own weight, but it must be sufficiently strong to resist the pressure of metal. This fact is somewhat overlooked, especially with copes, and while the sand supports itself, the upward pressure tends to lift the sand, even although the box part may be secured. The tendency to lift is somewhat safeguarded by resting weights over the top edge of the box. Unless for small work, it is certainly safer for the boxes to carry bars, and other methods of strengthening moulds made in boxes which are dealt with in this article are simply expedients, and supplementary to the bars. There are times when bars are not possible, and yet support must be given to the sand, but, as a rule, additional strength is given in conjunction with box bars, and in a general sense this is known as rodding.

Sprigs.

The simplest form of support given to parts of a mould involves the use of sprigs. They are employed to strengthen sharp corners, particularly if the corners are likely to be in the path of the direct flow of the metal, and isolated projecting bodies of sand, which have little strength in themselves to resist the pressure of the metal, should also be carefully sprigged. There is very special need for the use of sprigs in moulds for steel, not that they will bind the weak part to the main body of the mould. Thus in strengthening corners sprigs should be set at an angle as shown in Fig. 1.

Rodding.

The term rodding, used in connection with a mould, implies that greater support is necessary than would be supplied by sprigs, although the principle is the same, and the use of sprigs is only another form of rodding. Rodding consists in introducing pieces of wrought or cast iron into the sand during the process of ramming, and in such a way that they support the mould. Any old pieces of iron from ⅜ in. to ¾ in. round or square will answer the purpose, and to increase their value in sustaining the mould they are dipped in clay wash, so that the sand will adhere to them. They are used particularly for overhanging parts of the mould in order to reinforce the sand. Thus ribs, flanges or other projections from the sides of a mould, the patterns for which are drawn in after the main body has been removed, leaving the sand forming the top impression partly suspended, need to be rodded. Fig. 2 shows this form of reinforcement. Pieces of iron are introduced for support even when the shape of the sides of the mould is continuous, and not broken by other impressions. The necessity for their use in such instances occurs in deep moulds when a consider-

able body of sand is present between the box side and the mould, and when there would otherwise be possibility of the sand giving way under its own weight, thus causing it to slip into the mould. Fig. 3 shows the method of their use in deep cylindrical moulds, pieces of iron from 9 in. to 12 in. long being bedded into the sand about 4 in. or 5 in. apart, in layers radiating towards the centre of the job. There should be 9 in. or 10 in. between the layers until the full height of the mould has been rammed.

Another form of rodding is necessary to give support to the sand forming middle parts. In some instances it is better for the box part to have short parts projecting from the sides, but not infrequently middle parts, merely consist of a plain frame, and the amount of sand to be carried may be such as to need support. It is only necessary to give lifting strength to the sand as it comes between the drag and cope and strength to sustain its shape before the pressure of the metal is not needed. Obviously the same form of rodding illustrated in Fig. 3 would be useless for middle parts which are to be lifted, unless the sand is also supported with bars, because, without bars, the rods not being secured to the box, would merely add to the weight of sand and the mould would be more likely to collapse. It is therefore necessary either to rest the rodding on the internal ledge of the box part, as shown in Fig. 4, or, if the box side is straight, to wedge it between the sides. Pieces of iron fixed between the sides of the box may be wired together and claywashed. A middle part does not need much supporting, as a rule, because much of the sand is removed from the centre, and if the inside of the box is claywashed, or only swabbed with water, it assists the sand to adhere more firmly to the box sides, and by so doing possibly dispenses with rodding.

Lifters or Gaggers.

When pieces of iron are introduced in a mould to be used to support projecting parts of the mould which are to be lifted with the box they are known as lifters or gaggers, and the process of introducing them is termed liftering. In principle it is really another form of rodding, but since their use has to do with the lifting strength of the mould more particularly, the term lifters is very appropriate. Lifters therefore concern the cope more than any other part of the mould, though the expression may be applied to the rodding of a middle part. As has been previously stated the drag usually embraces the major portion of the mould, the cope being a cover to take the top impression, and the cope box is made accordingly with straight bars. Very often, owing to some projection required on the top of the casting, or due to the fact that it is necessary to make a joint of the mould below the upper surface of the pattern, the joint of the mould is lower than the joint of the moulding box, and in consequence it is necessary to carry additional sand with the cope. It is with the supporting of this lifting sand that lifters are primarily concerned. In special instances they may also be used when the cover is comparatively flat and flush with the joint of the box. Thus, in some moulds, the top is liable to be drawn by the heat of the metal unless it is well rammed and supported. The cope is likely to draw when it is under the direct influence of the heat of the metal during the whole time of casting a large job and when the surface involved is considerable. The heat may cause parts of the cope to fall on the metal owing to the surface becoming dried, if it is a green-sand mould, to a certain depth, or due to the sand not being sufficiently strong or not rammed sufficiently hard in a dry-sand mould, but it may also be due to insufficient liftering. If the moulding sand has an excess of lime in its composition even liftering very closely will not prevent a draw of the cope under such conditions. Then, with large runners passing through the cope, when the face is unsupported by the drag, the pressure of the flow of metal is likely to carry part of the mould with it, or, in the case of risers, the force by which air and gases pass through may remove parts of the mould unless the sand is strengthened. In the main, however, lifters are employed, as the name implies, for giving that support to sand which will render it capable of being lifted.

In the non-ferrous and steel foundries lifters are usually of wrought iron, and this material is also used to a considerable extent in iron foundries, but cast-iron lifters are also employed. Wrought-iron lifters are readily bent to suit varying surfaces, and any old piece of iron about $\frac{3}{4}$ in. to $\frac{5}{8}$ in., either round or square, will work in for the purpose, providing it is long enough. The shape of these lifters vary, some possessing a single projection or toe, while others have the projections on each side. In some instances it may be necessary to hook the lifters on box bars, but they should only be used when the ordinary type would not have a firm enough hold in the sand. Projecting lifters are likely to be caught when closing the mould, and the jerk given to it may disturb the sand about the other end. Double lifters are sometimes used, being carried over the box bars, but not as a general rule. A number of different kinds used is shown in Fig. 5.

Cast-iron lifters are generally cast in a permanent mould revolving on trunnions and supported on standards. These permanent moulds are of cast iron, usually double sided, and after the metal has been cast into the moulds on one side it is turned over, which brings it into contact with a stopper, and the chilled castings drop out. At the same time the inverted side of the mould can be cast. Many lifters can be cast in a comparatively short time, and the sizes vary. Cast-iron lifters are more rigid than wrought iron, and they are more easily broken to a convenient length if too long. An illustration of a form of permanent mould is shown in Fig. 6.

When introducing lifters it is important to remember that when they are to be used for carrying part of the mould projecting from the box part they should be as long as possible without actually being beyond the top of the box. Many moulders use lifters haphazardly, and, in many cases they do more harm than good, owing to the slight hold they have in the main body of the cope. They are more effectual against bars, and they should be set vertically, although the toe can be set to suit the work. Fig. 7 illustrates the use of cast-iron lifters, right and wrong method. Additional short wood bars are sometimes introduced between existing cast-iron bars, and these can be made as deep as is desirable for the lift to be made. These small bars, which are sometimes referred to as "soldiers," should be used in conjunction with lifters, when it is possible and a deep lift is required to be made. The toe of the lifter should not be less than $\frac{1}{2}$ in. from the face of the mould to prevent the casting being marked.

Grids.

When very deep lifts are to be made, and, in the opinion of the moulder, lifters would either be insufficient or too many would be required, cast grids may be used, as in Fig. 8. Some moulders prefer this form of support for large work when a considerable lift must be made in the cope, but their special value is in supporting bodies of sand which are not carried in boxes, as, for instance, cores or loose parts of the mould, which must be lifted separately in order to withdraw the pattern or to introduce cores. It is, however, their particular usefulness in giving support to green or dry sand moulds that this article refers to. When ordinary lifters depend upon the bars and the sand rammed between them to give them sufficient support so that they may lift the projecting part of the mould, grids are suspended by hangers or S hooks, or when staples are cast in them, they may be suspended on iron bars resting on the top of the box, but invariably packing is wedged between the grids and the bottom of the box bars so that they will remain rigid when the box is lifted and turned over.

Sometimes gaggers or prods are cast to grids when the lift is of an exceptional character, or bits of wrought iron may be cast in the grid, but, as a rule, the ordinary flat grid is more frequently employed. For ordinary lifts in the cope, which would involve a large number of lifters suspended from the box bars, any flat pieces of grid may be employed to cover the area to be lifted, and hooks used to suspend them from the bars. If one grid can be obtained to cover the area it is better, because the number of hooks projecting beyond the cope is reduced. These hooks, however, are not a source of danger, as are suspended lifters,

because the grids are generally packed and wedged —or they ought to be—when the distance from the bottom of the box bars and pattern is considerable. An illustration showing the method of securing these grids is indicated by Fig. 9. When there are facilities for using staples in the grids it is an advantage to leave the top of the cope quite clear. Loose box-bars frequently have holes cast in them in order that lifters may be kept below the surface and iron bars can be passed through these holes, on which are suspended stapled grids, as shown in Fig. 10. These, too, need to be packed and wedged. Grids are exceptionally useful when the full lift to be made would be too great for a single lift with the cope such as is illustrated in Fig. 11. In this instance the core is made in the mould, and because of its depth and the difficulty of obtaining a clean lift with the cope, it is advisable to lift it as a separate piece after the cope has been removed, and it is necessary to introduce a grid to which the sand will adhere to facilitate lifting. Even without the central part of the mould there is quite a good lift to be made with the cope, and a grid is very helpful. In both cases gaggers can profitably be cast with the grids in order that support may be given to the sand over the full depth of the lift. Staples should be cast in the grid for the loose part or cod, to give it its recognised term, and they should be of such a length that when the grid is located they are just below the cope joint in order that they will be easy of access for lifting.

Sometimes pieces of wrought iron are cast in grids instead of cast-iron gaggers, or they may be used in conjunction with cast gaggers, as in the grid for the rod in Fig. 11. The sketch, Fig. 12, shows the two grids used in Fig. 11. It is important to keep the grid well clear of the face of the mould, particularly when the metal to be cast contracts considerably, otherwise the resistance it offers may be such as to cause the casting to crack. Wrought-iron gaggers are frequently helpful in parts of a grid, subject to strain from contracting metal, because they yield to the strain.

Grids are made in open sand and on a level bed by means of stamps and gagger sticks. The shape of the grid is first marked out on the level bed, and the impression made with a wood stamp. There are a few different forms of stamps, and one which is in common use is shown in Fig. 13. Gagger sticks are sometimes of wood, though usually they are wrought iron, either about 1 in. dia. or 1¼ by ½ in. rectangular, and tapered as shown in Fig. 14. They may be bent to form the impression for curved gaggers, and the length of gagger desired is marked on the sticks, which are pressed into the grid impression, at intervals of about 4 in., depending upon the needs of the grid being made. Staples are introduced in the most convenient position for maintaining equilibrium, if used for a rod, and having the ends splayed, and projecting into the grid impression so that the metal will surround and fuse them. They may be pushed into the sand, leaving only the ends visible, or they may be supported in a vertical direction above the mould by means of bricks, according to the direction the staples are required to be, relative to the gaggers.

Chelsea Polytechnic.

The Michaelmas term of this college opened on September 25. We note with pleasure that foundry evening classes are to be arranged, but no definite time is fixed. Whilst not presuming to interfere with the organisation of the school, we feel that it would be appreciated by London foundrymen if Thursday was not chosen, as it is on this night that the local branches of the Institution of British Foundrymen and the Institute of Metals meet. The metallurgical department is controlled by Mr. J. B. Coleman, A.R.C.Sc (head of department) and Mr. W. A. Naish, A.R.S.M., M.I.Brit.F. The fees are very reasonable, being 20s. for one evening per week and 10s. for each additional evening. The school is very centrally situated at Manresa Road, S.W.3, and is served by the District Railway, tramway service No. 34, and eight omnibus routes.

Making Steel without Pig-Iron.

In support of the assertion that it is possible to produce by an "all-scrap" process steel of high quality in the basic open-hearth furnace and at a low cost, MR. EDWIN F. CONE in a recent article* records the fact that at a leading American steel-making plant—that of the Central Iron and Steel Company, at Harrisburg, Pa.—plate steel has been made in marketable quantities for the past four years without the use of any pig-iron. Indeed, since the latter period of the war the Company's three blast furnaces have been idle while the steel plant has been in active operation.

In describing the method adopted the author indicates that it differs from those practised at other plants where departures have been made from the usual pig and scrap process. The process adopted at Harrisburg is the subject of a patent granted to Mr. Robert H. Irons and assigned to the Company, and its distinguishing feature is the maintenance of a high residual manganese throughout the period of the heat. The presence of certain quantities of manganese during the melting-down period now characterises the operation both in acid and basic open-hearth steel-making at many plants, and the practice at Harrisburg may be considered as the development of this feature to its largest possibilities. Two well-known features of open-hearth practice are prominent in the patent:—(1) The use of carbonaceous matter to reduce the charge of pig-iron; (2) the use of manganese-bearing materials, thereby bringing about the elimination of sulphur as manganese sulphide, and securing the advantage of tapping with a high residual manganese. To secure this residual manganese, high-grade manganese ore from Brazil is used regularly as a part of each charge. About 2 to 2½ tons is ordinarily used in a 90-ton heat. The reduced manganese from the ore is alloyed with the steel, the slag being at the same time brought to the point of saturation with manganese. The desired manganese in the bath is thus obtained, and at the time when the heat is ready for tapping the amount of residual manganese is fairly constant at 0.15 to 0.30 per cent. To prevent the steel from losing any of this residual manganese because of insufficient oxide of manganese in the slag, the capacity of the slag in lime and oxide of iron is increased which, combined with the manganese oxide acting as a base, exerts the desired effect on the manganese of the bath. The *rôle* of this residual manganese is two-fold:—(1) Its presence during the whole refining operation prevents any oxidation of the iron in the bath; (2) it is an important factor in eliminating sulphur.

Aside from the manganese ore and the regular and necessary amount of lime, the charge is made up of scrap steel and scrap iron in proportions varying from 60 to 90 per cent. of the former and from 40 down to 10 per cent. of the latter, largely heavy melting grades. The regulation of the mixture depends on market conditions and requires a constant study of the price and availability of the scrap brought in from outside. The flexibility of the charge is its feature, it being possible to make a heat with 90 per cent. steel scrap or up to 40 per cent. scrap iron, with no variation in quality.

Another factor in the charge is carbon in the form of coal, coke, or charcoal, the amount depending on conditions. An interesting feature at the plant in question is the use of river coal, really "buckwheat" anthracite. Tons of this are being taken daily from the Susquehanna River, which runs alongside the plant. The coal is carefully washed, dried, and screened and used in each charge in varying proportions with the scrap and other materials. It furnishes carbon and plays other lesser *rôles* in the refining process. The same coal at present is fired under boilers to raise the steam used in the plant.

The purifying effect of the residual manganese, which is the key to the success of this unique "scrap and carbon" process, is not a new principle, but the method of its application is.

* "The Iron Age," September 7

A Study of the Weight of Iron Castings.*

By John D. Wise, Urbana, Ill.

It might appear superficially that all castings made in the same manner from the same pattern must necessarily be of the same weight, but observation of the weights of various castings made from the same pattern under identical conditions has disclosed surprising variations. The purchaser of castings makes a peculiar concession to the foundryman. In his dealings with all other persons from whom he buys, he is guided by the principle that he must know in advance the amount of the invoice which will be rendered. To the foundryman, however, he gives a more or less *carte blanche* for a number of castings the weights of which generally do not correspond with those of previous shipments. The purchaser of castings realises that the casting of minimum weight which he accepts serves its purpose as well or better than those of greater weight. Frequently the machine shop purchases the casting and in this way has the direct interest in excess weight referred to above. Three other considerations enter into its problem in dealing with the overweight casting. First and most important is the removal of the surplus metal which is present on the surfaces to be finished. This frequently assumes dangerous proportions. For instance, it is not uncommon to find $\frac{3}{4}$ in. of stock where $\frac{1}{4}$ in. would be sufficient to eliminate the skin of the metal and to escape minor surface defects. The relative amount of metal occurring on finish pads and on portions where machining is not necessary will be covered later.

① Casting Number	② Casting Name	③ Weight when hand molded	④ Weight when Mach. molded	⑤ Reduct. ion-% ③-④ ③x100	⑥ Saving per cent in lbs ③-④	⑦ No Rqd	⑧ Rate per lb ¢	⑨ Total $ Saved ⑥x⑦x⑧
C-5R	Truck	38.6	33.3	13.7	5.3	220	6¢	73.79
D-6	Base	340	312	8.2	28	15	6¢	27.30
C-42A	Drawcyl cover	49.6	45	33	4.6	10	6¢	2.87
B-74	Sand guard	24	23	4.1	1	20	6¢	1.25
C-77	Squaring shaft	65	58.	10.7	7	10	9	6.30
D-78	Frame	340	300	11.7	40	10	9	36.00
D 79A	Leveling table	121	112.	7.4	9	10	9	8.10
D-80A	Base	264	200	24.2	64	35	6¢	145.60
C-201A	R.O.Bracket	50	38.	24	12.	5	9	5.40
C 202A	" "	50	38.	34.5	20.	5	9	9.00
C-227	Sand guard cover	123.	110	10.6	13.	1	6¢	.81
B-308	Safety st collar	2.5	1.85	30	.65	45	6¢	1.90
B-310	Insp hole cover.	6.2	5.5	11.3	7	10	6¢	4.4
B-430	Leveling levers	4.3	4.	7.	3	30	9	.81
B-431	" "	5.3	3.3	37.7	2.	30	9	5.40
B-549	Cylinder head	79	60	24	19	15	6¢	17.81
A 1500	Muffler section	34	3.	11.7	.4	100	7	2.80
G-1500	" "	3.6	3.2	11.1	4	150	7	4.20
C-2541	Wheel	38	37.4	1.5	.6	100	6¢	3.90
A-2599	Base	324	311.	4.	13	10	9	1.70
B-2638	Crank hub	4.1	4.1	0	0			
C-2651	" disc	12.4	9.6	22.6	2.8	20	9	5.04
C-2768	Bracket	2	1.3	35.	7	40	9	2.52
B-3360	Cylinder head	55	54.8	.36	.2	10	6¢	.12
A-5018	Jolt table	268	249	7.1	19	10	6¢	12.35
A-5732	Draw piston	116	113	2.6	3	1	6¢	.19
A-5872	Base top cover	12.	11	8.3	1	20	6¢	1.30
A-7591	Muffler	2.	1.8	10.	.2	40	7	.56
A-7745	Car frame	71	56	21.2	15	20	6¢	19.50
B 7745	" "	66	54.	18.2	12.	20	6¢	15.60
A-7864	Base	282	225	20.2	57	60	6¢	222.30
A-7879	Shield	33	29.	12.1	4	60	6¢	15.60
A 7883	Wheel	27.2	24.3	10.6	2.9	500	6¢	94.25
A-7982	Pressure hd stop	12.3	12.	8.9	.3	35	6¢	.68
A 8331	R.O Trunion	66	64.	3	2.	20	6¢	2.50
B-8331	" "	68.8	63.3	8	5.5	20	6¢	6.87
A-8405	Jolt piston	527	475	9.9	52.	10	6¢	32.50
A-8415	Housing bushing	248	246.	8	2.	10	6¢	1.25
A-8792	Jolt piston	330	316.	4.2	14	15	6¢	13.12
D-8929	Leveling car	516	480	6.6	36	15	6¢	33.75
C-8931	Draw cylinder	722	535	26	187	15	6¢	175.31
C-8934	Housing bushing	422	415	1.6	7	15	6¢	6.56
TOTALS		5802.3	5137.75		664.55	1787		
AVERAGES		138.1	122.3	10.8	15.8	42.5		
TOTAL SAVING								$1029.25

FIG. 1.—TABLE SHOWING COMPARATIVE WEIGHTS OF CASTINGS.

Handling Problem is Affected.

In most cases the addition of 10 per cent. to the weight of a given casting will not change it from a hand-lifted weight to a crane-requiring weight or from one crane to another of larger capacity, but this will happen in a certain per cent. of the cases and is, of course, an avoidable loss. The human factor enters here also, since the work of handling castings by hand is materially lessened when the weight of the castings handled is decreased an average of 5 to 10 per cent. Of course, such a decrease in weight reduces fatigue and increases efficiency.

Another concern of the machine shop in connection with overweight castings is in the use of jigs or fixtures. Since overweight takes the form of excess metal on the outside of the casting it follows that this excess metal interferes with jigs and fixtures, causing either a loss of time for adjustment or rejection of the casting. The rapidly increasing use of jigs makes this factor one of prime importance.

Foundrymen should be deeply interested in the standardisation of weights of castings and in the reduction of standardised weight to a minimum. By decreasing the weight of all the castings produced from one pattern to the minimum weight necessary to meet specifications, the foundryman will decrease the amount of money which he receives, since his invoice is rendered on a per pound basis. This result might appear to be to his disadvantage and cannot be explained away by assuming that the decreased amount of iron melted and handled will show a saving that will offset the loss of the revenue from the excess weight. The real solution for the foundryman consists in a moral interpretation of his duties toward his customers—a policy or rendering the maximum service for each shilling charged. He constantly should endeavour to keep the weight of the casting down to the minimum.

Ultimately the foundryman who seeks to build up his business on the principle of furnishing minimum-weight castings will outdistance competitors who cannot render the same service. Also he will be able to meet the competition of the manufacturers of forgings and pressed steel parts, both of whom may be able to replace a casting by a member of less weight and greater uniformity and frequently at a less cost per piece. This competition presents a definite challenge to the foundry industry to meet the quality as well as the price of these products.

Fig. 1 presents the result of a comparison of the weights of castings made from the same pattern or from patterns slightly altered to reduce the weight, maintaining in every case, however, the same requirements for the finished castings. Each horizontal line contains a record of the castings made from one pattern when hand moulded and later when machine moulded. The weights given in columns 3 and 4 are average weights of a number of castings. Column 5 shows the weight reduction in per cent.; columns 6, 7, 8 and 9 show the weight reduction in pounds per casting, the number required, the price per pound, and lastly, the value of the saving for the quantity considered. The average weight reduction of 10.8 per cent. indicates that a study of the reasons for the saving will produce important results since the saving is large enough to be of considerable importance. In considering the problem of weight reduction it will be convenient to set forth the successive steps in the making of a mould, assuming ordinary side floor work of moderate size. Beginning with the blueprint the steps in the making of a casting are as follows:—(1) The amount of finish metal to be allowed; (2) method of moulding; (3) decide on the amount of draft; (4) make the pattern; (5) ram the mould; (6) rap the pattern; (7) draw the pattern; (8) sleek the mould; (9) patch the mould; and (10) close and pour.

Patternmaker Determines Allowances.

It will be noticed that the first three of the most important steps leading to the producing of a casting from a blueprint are performed in the pattern shop before the pattern is made. In

* A Paper read before the American Foundrymen's Association

too many cases the patternmaker decides these important factors without conferring with the foundry and machine departments. In so doing he influences to a large degree the subsequent methods these departments must employ and to a large degree the amount of unnecessary work to which they may be subjected. Obviously a more logical plan should be adopted at the start and carried throughout all the operations occurring between the blueprint and the finished casting. No single operation should be considered as a separate unit, but each should be considered as a part of one logical plan.

The first factor, *deciding upon the amount of finish metal necessary*, is usually settled by the patternmaker in accordance with the following general rule: "It is always possible to machine off surplus metal while none can be added." He thus adds a "safe" amount of metal in order to allow for the unpredictable "come and go" of the casting. If it were known that the castings would be uniform in size it then would be possible to allow only enough finish metal to require the removal of the skin and its attendant surface imperfections. But all foundrymen are familiar with the fact that hand moulding cannot produce this uniformity. Happily, most of them are also aware of the fact that machine-moulded castings possess uniformity of size and weight. It is a matter of general experience in the automotive and other industries that machine moulding produces castings of uniform size and without excess metal for the machine shop to remove.

The second factor, *deciding upon the method of moulding*, consists chiefly in the location of the parting line which seriously affects the production of the casting, but does not usually exert any effect on the weight.

Unnecessary Draft.

The third factor, *deciding upon the amount of draft necessary*, affects the weight to a large degree. Again the patternmaker generally decides this question without conferring with the foundryman who must use the pattern. He works on the principle that "too much draft will not harm the pattern while too little will cause excessive breaking of the mould and will cause the pattern to be returned for alterations." He therefore allows liberal draft, a part of which is necessary and a part of which is superfluous. This excessive draft adds a constant and unnecessary weight of metal to the finished casting. Draft is necessarily primarily in hand moulding since it is impossible to draw the pattern straight upward from the sand by hand. Theoretically a pattern drawn vertically need have no draft. This action is closely approximated by moulding machines which are much more accurate than a human hand can be.

The fourth factor, *making the pattern*, has far-reaching and interesting effects upon many other problems having to do with the cost of the casting but not on the item of weight. When the pattern is received in the foundry, the first operation performed is the *ramming the sand around it*. This introduces variable elements which greatly affect the weight. The ideal condition desired in ramming is that the sand shall be of the maximum density and yet allow proper venting; and second, that it shall be of exactly uniform density over the entire surface of the pattern. The skilled moulder approaches, only in a rough way, the ideal condition. He obviously cannot produce a mould of exactly even density and the result invariably follows that the equal liquid pressure of the mould forces back the sand at the soft portions and produces at these points swells on the casting, all of which are unnecessary and add preventable weight. It also is true that the maximum density of sand is never obtained, for the moulder leaves a large margin of safety to be certain of avoiding trouble due to lack of venting in the sand. Obviously this factor cannot be entirely eliminated but it can be reduced to a negligible quantity. The moulding machine, with its constant uniformity from the beginning to the end of the day and from day to day, can accomplish exact uniformity of the entire surface of the mould and can approach the maximum uniform density much more closely than can the moulder attempting it by hand.

Excessive Rapping.

The sixth factor, *rapping the pattern*, is an operation introduced by the moulder for the purpose of enlarging the mould in order that the pattern may be withdrawn from the least possible amount of damage to the sand. Rapping accomplishes this purpose, but it also enlarges the cavity so that overweight is introduced into the casting. When considering the weight of the casting with a view of reducing it to a minimum, it is readily apparent that if rapping is eliminated entirely the reduction in weight sought for will be obtained. By omitting rapping, however, the moulder would invariably make matters worse by introducing excessive patching of the mould. Therefore he is forced to choose rapping as the lesser of the two evils. Again, the moulding machine is suitable for accomplishing that which is impossible to the moulder working by hand. It will draw the pattern vertically upward from the mould, loosening it from the clinging action of the sand by means of air or electrically operated vibrator which does not appreciably enlarge the cavity. In this way the rapping of the pattern can be eliminated with a resultant saving in weight.

The eighth and ninth factors, *sleeking* and *patching the mould*, are in reality repair operations to overcome the damage done to the mould by the withdrawal of the pattern. Both of these operations should be eliminated, but this is not possible when the pattern is drawn by hand. Moulding machines draw the pattern so accurately that no sleeking and patching are necessary.

The tenth factor, *closing and pouring the mould*, introduces little or no variation in the weight, unless the density of the iron is affected slightly by the height of pouring head or by such special methods as the rotation of moulds, while being poured.

By dividing the ten operations outlined into

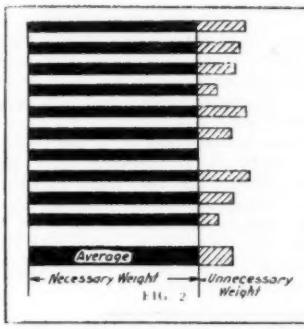


FIG. 2

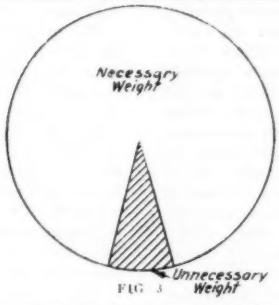


FIG. 3

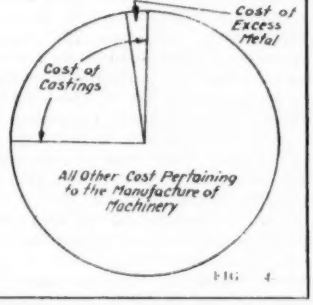


FIG. 4

FIG. 2.—TYPICAL CONDITION EXISTING IN THE CASE OF CASTINGS MADE FROM ONE PATTERN BY HAND MOULDING.

FIG. 3.—THE AVERAGE 10.8 PER CENT. REDUCTION OF WEIGHT SHOWN IN FIG. 1 IS REPRESENTED HERE GRAPHICALLY.

FIG. 4.—THE COST OF EXCESS METAL TO THE MANUFACTURER OF MACHINERY IS SHOWN GRAPHICALLY.

two groups, first, those performed in the pattern shop, and second, those performed in the foundry, it is apparent that the problem is a common one for the foundry, machine shop, and the pattern shop to solve before work on the pattern is started. If each of these departments is to perform its particular portion of the work in the least time and at minimum cost the operation must be planned jointly from beginning to end by those who are responsible for its execution.

Variable and Constant Factors.

To attack more intelligently the general problems of casting overweight the operations causing it may be divided into two classes; First, those causing variable amounts of overweight, and second, those causing constant amounts of overweight.

The operations causing variable excess weight are as follows: (1) Non-uniform ramming of the mould; (2) rapping of the pattern; (3) drawing of the pattern obliquely; and (4) sleeking and patching the mould.

The operations causing constant excess weight are as follows: (1) Too much finish metal; (2) Too much draft.

It is important to know definitely which of these factors adds the most excess weight to the casting so that their relative importance may be ascertained and treated accordingly.

No comprehensive study has been made of the importance of these different operations, and therefore no answer can be definitely given here. Excessive finish allowance metal exists on the parts which are to be machined and consequently, on a casting which is to be machined all over, this extra metal may take the shape of an extra ¼ in., more or less, added to the entire surface of the casting. Its percentage to the total weight varies with the shape of the casting. It would be minimum on a spherical casting and maximum on a thin, flat casting of a large area, such as a piano plate, and reach the maximum on a casting which is machined all over. Excess metal allowed for finish may be the most important factor in overweight or it may be one of the smallest considerations, depending entirely upon the shape of the casting.

Excessive draft is similarly variable. It is not necessary to use any draft on a spherical pattern parted on the diameter, and it follows that such a casting would not carry any extra metal on account of draft. A cubical block would necessarily have draft on four of its six sides and the excess metal in such a case would be relatively heavy. A casting which is deep in proportion to its area will have on it a maximum of excess metal due to draft allowance.

Swells on Castings.

Swells on the castings are of two kinds. The first is an enlarging of the entire casting which is caused by the giving of the sand as the liquid pressure of the metal is exerted upon it. This is uniform over the entire surface, and in amount is inversely in proportion to the density of the sand. The second class of swells are those which are confined to a small portion of the casting surface caused by light ramming at that particular point. These may be so slight as to be almost imperceptible in the case of an experienced moulder, and may assume such proportions as to be highly objectionable in the case of unskilled men. However, both are entirely eliminated in machine moulding.

Rapping the pattern is usually performed backward and forward and from right to left but seldom by driving the pattern into the sand. The casting is enlarged, therefore, rather uniformly on the sides but little, if any, on the top and bottom. The amount of enlargement depends upon the amount of rapping and this is determined by several things. A pattern of a shape difficult to draw is usually rapped more than one of easy drawing shape, and an inexperienced moulder finds it necessary to rap more strongly than the experienced moulder. The use of vibrators eliminates excess weight due to rapping.

The sleeking process enlarges the mould uniformly, or approximately so, over the entire surface and affects different shapes of castings in the same manner that excess metal for finishing purposes affects them. The principal point to bear in mind in regard to sleeking is that it is an entirely preventable evil, since by eliminating rapping and by drawing the pattern accurately it is not necessary. Patching is in much the same class as sleeking, except that it is usually local in effect. When building up a broken portion of the mould the moulder naturally puts extra metal on the casting rather than not leaving enough.

Fig. 1 presents the data gathered when 42 light machinery patterns were changed from hand to machine moulding. Fig. 2 shows the typical condition existing in the case of the castings made from one pattern when hand moulded. The outstanding feature is the erratic variation. For the 42 different cases considered in Fig. 1 the average reduction is 10.8 per cent. in weight. This is shown graphically in Fig. 3. The effects of this reduction are far reaching. Castings are purchased by weight; therefore the cost of rough castings is decreased 10.8 per cent. to the user.

Since the cost of castings is about 20 to 30 per cent. of the gross cost of light machinery this means a saving of 2 to 3 per cent. which is added directly to the profit of the manufacturer, as indicated in Fig. 4.

Nor is this all. Following the casting into the machine shop there are several items that will result in distinct savings. (1) There is less metal to be machined off; (2) there is less layout work; (3) castings may be handled more rapidly in jigs; and (4) there is less filing to be done on the rough surfaces.

No investigation has been made of the amount of saving effected by these changes in the machine shop, but, whatever their magnitude, they decrease the cost of the finished casting and are a step in the right direction.

At present there is evidence of a tendency for castings to be replaced by pressed steel parts. Savings can be effected in the total number of hours of labour expended on a casting, in the amount of overhead burden borne by the casting, and in the amount of material used. Moreover, a saving of 10.8 per cent. in weight is possible and highly desirable.

Reducing Hematite to Magnetite with Methane.—During recent experiments on the reduction of iron ores with fuel gases carried out at the Pacific Experiment Station of the U.S. Bureau of Mines, it was noticed that at temperatures up to 800 deg. C. the methane in these gases was practically inert as compared with hydrogen or carbon monoxide. A number of experiments were then carried out with mixtures of methane and hydrogen over a wide range of temperatures to find out when the methane would begin to function actively as a reducing agent. While it reacted slowly at all temperatures tested, its reaction in the reduction of hematite to magnetite, the first stage in the reduction of iron, did not become sufficiently rapid to be of industrial importance until temperatures of over 900 deg. C. were used. A rough approximation of the velocity constant of this reaction was made for all the temperatures at which tests were made in order to obtain some unit figures of value in designing industrial apparatus for carrying out this reaction. The details of these experiments are contained in Serial 2,382, published by the Bureau.

Spanish Iron and Steel Industry Developments.—During the war Spain made great efforts to become independent of foreign countries by completing or installing important iron and steel plants. Among these may be mentioned the works at Reinosa (Santander) erected by the Sociedad Española de Construccion Naval, whose shipyards at Cartagena, Cadiz, Ferrol and Sestao (Bilbao) will form important consumers for the products of the Reinosa works. The Construccion Naval has secured an order for six electric locos. The Sociedad Duro-Felguera (Oviedo) intends to increase its production to 60,000 tons of steel yearly, and is electrifying its rolling mills. The Altos Hornos de Bilbao have continued to improve their plants. A syndicate of Bilbao has erected at Sagunto (Valencia) blast furnaces which will be able to supply 300,000 tons of pig-iron yearly. In 1918 Spain consumed 450,000 tons of home-made pig-iron and about 38,000 tons imported. Imports revived after the war, but the Spanish iron and steel makers are endeavouring to check them by means of the development of their own plants and the new Customs tariff.

White Metals.*

By A. H. Mundey, C. C. Bissett and J. Cartland.

The family of white metals is a very large one, and although a great deal of investigatory work has been carried out in connection with it, the amount of attention it has received, compared with that accorded to the alloys of which copper is the chief constituent, is very small. Probably it is for this reason that the manufacture of white metals, particularly of those chiefly composed of tin, antimony, and lead, has been regarded as a business with many so-called trade secrets. This latter condition no longer obtains, as it is obvious that the only secret is that which is the result of patient investigation, and the exercise of the highest skill and experience available.

For practical purposes alloys which are generally described as white metals may be classified into (1) anti-friction or bearing metals, and (2) other qualities, such as solders, die-casting metals, etc.

The exact physical properties required in a lining for a bearing are not finally agreed upon. It is generally admitted that in the ideal journal the shaft never comes in contact with the bearing at all, the metallic surfaces being completely separated by a film of oil. This condition would at first sight appear to render the particular material of the bearing a matter of small importance, but the material itself plays an important part in the maintenance of the oil film.

Engineers demand a certain balance of properties in a bearing. It must be sufficiently hard and strong to resist distortion under working loads and irregular stresses. It must present a fine surface, not liable to rapid abrasion, and on the other hand must have a measure of plasticity which will permit it to accommodate itself to slight want of alignment of shafting; finally, it must be sufficiently tough to resist fracture under shock. Experience supports the opinion that a homogeneous metal is not suitable for a bearing, that neither a single metal nor an alloy which is a solid solution can be employed with success, and that either a metal consisting of a soft matrix with hard crystals embedded in it, or a hard metal interspersed with veins of a softer constituent, has the necessary surface for a practical bearing alloy. The best service is obtained from an alloy which, though wanting in homogeneity, has its undissolved constituents distributed in a regular and uniform manner. The authors are of opinion that this mottled surface, in which the harder portions are in slight relief, provides a number of pools and canals which serve to retain the oil film, and, on account of their fine and even distribution, promote the spreading of the oil over the surface by a function which is closely related to capillarity.

The usual tests for tensile strength, hardness, and compression have been made on representative alloys. They are shown in Table I. The test-pieces were prepared by casting into a cast-iron stick mould under uniform conditions. The temperature of casting was about 350 deg. C., the mould being heated to about 100 deg. C. The acting portion of the test-piece was 0.564 in. in diameter, the length being 2 in., according to the usual formula. The Brinell tests were all taken with a 10-mm. ball at a uniform load of 500 kg. The compression tests were made by taking cylinders 0.564 in. dia. × 0.5 in. high. The first observation was made when a permanent deformation of 0.001 in. was produced, the ultimate figures when the test-piece was compressed to one-half its original height.

The choice of a bearing metal is often controlled by consideration of first cost. Tin being the most expensive constituent of the usual white bearing metals, the proportion of tin mainly affects the price. For the highest-powered engine bearings for automobile, aero, and similar services, the nine alloys whose compositions are given in Table II. may be looked upon as good representative types.

No. 1 alloy, which is quite free from lead, combines maximum toughness with strength. This metal was mostly favoured in aero-engines throughout the war, and gave generally excellent results. It is probably ideal for big-end bearings.

No. 2 is also a lead-free alloy, harder than No. 1, owing to the presence of a higher percentage of antimony. It has, however, a useful degree of toughness, and is very useful for general work for main bearings. The presence of a small quantity of lead in this alloy is of no great detriment if the even distribution of the constituents, which has been already emphasised, is insisted upon.

TABLE I.—*Mechanical Tests of Bearing Metals.*

Alloy No. (See Table II.)	Tensile test. Tons per sq. in.	Tensile test. Elongn. per cent. on 2 in.	Brinell No. 10 mm. ball 500 kg.	Compression test. Tons per sq. in. Yield point, 0.001 in.	Compression test. Tons per sq. in. Compressed to ½ length.
1 ..	5.12	11.60	24.9	3.569	14.732
2 ..	6.65	7.10	33.3	4.372	17.232
3 ..	5.60	0.00	34.5	4.284	17.640
4 ..	5.70	0.00	32.1	4.640	17.500
5 ..	5.04	0.00	27.1	3.696	12.856
6 ..	4.58	0.00	21.8	3.660	11.284
7 ..	5.48	0.00	31.3	4.016	12.212
8 ..	6.36	0.00	37.0	4.550	17.856
9 ..	4.69	2.80	24.9	3.590	13.356

As regards Alloy No. 3 it will be seen that the lead appears to cause the disappearance of any useful elongation, but the tensile test fails to show all we need in this case, for it is the experience of engineers that this particular alloy is excellent in its resistance to shock.

The so-called Babbitt metals are legion; the following may be regarded as fairly representative. Their real value depends not by any means only upon their actual percentage composition, but upon the care in preparing and melting, ensuring even distribution of the constituents.

Alloy No. 4 is very useful for heavy loads and high speeds; Diesel engines, turbines, rolling mills, locomotives.

TABLE II.—*Composition of Bearing Metals.*

Alloy No.	Tin. Per cent.	Antimony. Per cent.	Copper. Per cent.	Lead. Per cent.
1	93	3.5	3.5	—
2	86	10.5	3.5	—
3	83	10.5	2.5	4
4	80	11.0	3.0	6
5	60	10.0	1.5	28.5
6	40	10.0	1.5	48.5
7	20	15.0	1.5	63.5
8	78	11.0	11.0	—
9	5	15.0	—	80.0

Alloy No. 5 is used for internal-combustion engines of all types, steam-engines, dynamos, locomotives, etc.

No. 6 is a generally useful alloy for heavy pressure and medium speed or medium pressure and high speed; automobile engines, railway and tramway bearings.

No. 7 is also a useful metal for medium pressures and speed, or light pressure and high speed.

The white metal No. 8, commonly called plastic metal, is usually of the approximate composition given in Table II. In some cases a little lead is added. It is used very extensively by millwrights and marine engineers for repair jobs; it is hard and durable, and it is self-tinning. The constitution of this alloy lends itself to its employment in the special manner which has suggested its name. The period of solidification from the moment of the falling-out of the copper-tin constituent to the final freezing of the eutectic is an extended one, and during this period the metal is in a plastic condition; consisting at this time, as it does, of a mixture of crystals and liquid, it will "bind" in much the same way as thawing snow and for a similar reason. It is therefore capable of being spread and fashioned into the form required, somewhat similar to the function of making a

* Abstract of Paper read at the Swansea meeting of the Institute of Metals.

plumber's "wipe-joint." Repairs of an extensive character have been effected at sea and on the field behind the battle-lines with this metal, and the artificer who is working at a distance from his repair depôt or supply base is usually careful to have a small stock of it to hand.

The lead-base bearing metals are fairly represented by that known as magnolia metal (No. 9). This is usually of the composition shown in Table II., with sometimes a small portion of bismuth added. The same general rule obtains for the success of a lead-base anti-friction metal as for the tin-base alloys, the structure consisting of the hard cuboid tin-antimony crystals in a matrix of the tin-antimony-lead eutectic. Just as in the tin-base alloys these tin-antimony cuboid crystals stand up in slight relief *when in use*, and the slightly lower surface of the matrix assists the lubrication. These alloys deserve much more attention than they usually obtain, and in circumstances when the engineer can arrange with his designer to provide rather long bearings, ensuring the distribution of the load over an extended area, excellent results in running and endurance can be obtained.

It will be seen that the action of tin-base and lead-base bearing metals are very similar, the essential difference being that in the former the copper-tin epsilon constituent prevents the segregation of the tin-antimony crystals, and the matrix of tin hardened with copper is tougher than that of the lead-base alloys. Alloys of this character are specially useful in accommodating and rectifying slight want of alignment in the erection of shafting, or in similar conditions. It is worth noting that alloys of this description are being employed very largely at the present moment on continental railways, particularly in Central Europe.

Bearings of this alloy have recently been found to be capable of carrying their load and continuing their duty under increased temperatures to a greater extent than many tin-base bearing metals in similar circumstances. This is in agreement with theoretical considerations, but is by no means the commonly accepted view of engineers.

The employment of barium and calcium, as hardeners of lead for the preparation of bearing metals is a matter of great interest, but its importance from a manufacturer's point of view is considerably less at the present moment than it was during the war, when tin was scarce and correspondingly expensive, and when these alloys promised some relief as substitutes for tin-base alloys. The difficulties attending re-melting, due to the losses of the hardening constituents by oxidation, are very real, the production of excessive dross being a drawback, as the conditions under which metal has to be re-melted for relining bearings on service are frequently very different from those which obtain in a laboratory or in a well-ordered foundry.

Testing of Bearing Metals.

The testing of bearing metals is generally performed by running sets of bearings of the various alloys under service conditions for a certain period (if possible extending to several months) giving them constant attention and subjecting them under observation to conditions as nearly similar to one another as possible, so that the results may be fairly comparable. At the expiration of the period decided upon the bearings are examined, if they have not failed or given actual trouble in the meanwhile. The observed behaviour in running, and also their condition at the end of the trial, indicate their value: but the test is not a scientific one, and though thoroughly useful in showing that a certain alloy will make a satisfactory bearing, it is unsafe to condemn one which may have failed, as in trials of this character abnormal conditions may arise which escape notice.

A Thurston machine designed for oil testing had its bearings replaced by others of exactly similar form in the several alloys to be tested. Trial runs, using these bearings under similar conditions as to pressure, speed, and duration, were made, and figures obtained in (*a*) rise in temperature per 1,000 revolutions, (*b*) coefficient of friction as shown by the tendency to seize and indicated by the swing of the pendulum of the machine. The drawback to these trials consisted in the fact that some alloys were suitable for light loads and fast speeds, whilst others were more efficient for heavy loads and slower running. Actual comparisons are therefore not correct. In all cases the bearings are freely lubricated, usually by pad lubrication.

There is always to be noted the degree of finish of the bearing; this is met by the only reasonable method of boring and scraping the bearing to the highest possible degree of refinement in workmanship. The human element, represented by the skill of the mechanics, cannot be eliminated. Hammer dressing of bearings is a well-established custom, the evident intention being to consolidate the material by cold-working. In reality it has a slight softening effect, and in those alloys in which the hard constituents are closely packed the crystals are seriously crushed, and, by the destruction of their natural orientation, their interlocking is diminished and the alloy is weakened, or in some cases even cracked.

Summary.

(1) The chief value of white bearing metals is due to the way in which they maintain the oil film. This is effected by the hard constituents standing up *in use* in slight relief, the softer matrix thus forming numerous evenly distributed channels, which maintain the oil by capillarity. A single metal, or a metal consisting of a solid solution, will *not* function as a bearing metal.

(2) In the tin-base bearing metal the copper-tin epsilon crystals solidifying out first entangle the cuboid tin-antimony crystals which subsequently form and prevent their segregation, thus ensuring even distribution.

(3) The functions of tin-base and lead-base alloys are similar; the latter could be much more generally used than is the case at present, the chief differences being the action of the copper-tin crystals mentioned in (2) and the fact that the matrix in the tin base is tougher.

(4) The greatest care and skill must be exercised in the handling of bearing metals in practice, otherwise either the hardening constituents will be left in the ladle by liquidation or the metal will be overheated and the structure spoilt.

WILLIAM BEARDMORE & COMPANY, LIMITED, have constructed, and are experimenting with, a six cylinder aerial crude oil engine of a type which develops about 1,000 h.p. The fact that the new engine is being constructed at Parkhead lends significance to Lord Weir's remark at Renfrew Aerodrome recently when he said that he hoped to read within another ten years of an entry for the King's Cup of a "St. Mungo Mark 4" machine with a 2,000 h.p. Parkhead engine.

THE MOTHERWELL WAGON & ROLLING STOCK COMPANY, LIMITED, have recently been successful in obtaining the undernoted contracts:—North British Railway, 230 pairs wheels and axles; Caledonian Railway, 500 pairs wheels and axles; East Indian Railway, 100 pairs wheels and axles; Rohilkund and Kumaon Railway, 300 pairs wheels and axles; Burma Railways, 200 pairs wheels and axles. They have also to build 250 16-ton mineral wagons for the North British Railway, this being the balance of an order for 487 wagons.

THE TURBINE FURNACE COMPANY, LIMITED, of 238b, Gray's Inn Road, London, W.C., have lately taken orders for their furnaces from the United Steel Companies, Limited, Treeton, near Rotherham; the Butterley Company, Derby; Bradford Steel Rolling Mills, Birmingham; Fairbairn, Lawson, Combe, Barbour, Limited, Falls Foundry, Belfast; Richard Thomas & Company, Limited, Cwmfelin Tinplate Works, Swansea; the Seaton Delaval Coal Company, Seaton Delaval; and the Hackbridge Cable Company, Hackbridge, Surrey.

American Blast-Furnace Practice.—The rule for rating the capacities of blast furnaces adopted by the Southern Ohio Pig-Iron & Coke Association is based on the burning of a certain amount of a "base" coke in a given time (60 lbs. coke per cub. ft. of working volume in twenty-four hours). Starting with the idea that there is a definite rate of combustibility for a standard coke, assuming that the ore mixture contains 51.50 per cent. iron in the natural state, and arbitrarily using 1,800 lbs. of coke per ton of basic pig-iron when the fixed carbon in the coke is 90 per cent., it is a simple process to determine what any blast furnace should make under varying conditions of coke, ore mixture, and percentage of silicon in the pig-iron.

Contribution to the Discussion on Mr. Smalley's Paper on High Tenacity Brass and Bronze.

DR. F. JOHNSON wrote that he wished to congratulate the author on the presentation of a Paper of great interest, and one of far-reaching importance. It represented a combination of high technical skill, scientific knowledge and works experience, backed up by the resources of a big industrial organisation.

Much of the work described in the Paper bore upon problems with which the writer was familiar, and to a great extent some of his own work had been carried out in the same domain.

There was one charge which he would level at the author, which, however, sprang from no lack of appreciation of the splendid services rendered to foundrymen by the author's work, and that was that the Paper almost completely ignored the work which had been done by other investigators. There were, for instance, the researches of Charpy, Lohr, Guillet, Hudson, Professor Turner and his collaborators, and so on, which should, at least, have merited reference. The writer was particularly gratified to observe that Mr. Smalley accepted the constitutional diagram of the copper-zinc series so far as it related to the beta phase as based on the dimorphism of that phase. With this acceptance he (Dr. Johnson) wholly concurred.

With regard to the curves representing the relationships of mechanical properties to compositions, the writer felt that an insufficient number of points had been taken, apart from the fact that the constitutional diagram represented conditions much nearer to equilibrium than the author's alloys could be. But for practical purposes the author's results were invaluable. The writer was particularly interested to note that Mr. Smalley placed the alloy of maximum strength as existing in the all-beta field.

This confirmed the result which the writer had previously obtained, upon which considerable doubt had been cast, but which the author's results now entirely vindicated.

The results obtained by Mr. Smalley and by the writer are given herewith for comparison:—

No. and Composition.	Treatment.	Y.P. Tons per sq. in.	M.S. Tons per sq. in.	E. Per cent.
No. 12 from the writer's Inst. of Metals paper. Cu. 53.11 % Zn. 46.8 %	Cast bar annealed at 650° C. for 2 hrs.	10.53	30.4	37.5
From the author's present paper. Cu. 53.3 % Zn. 46.7 %	Cast bar as forged	9.0 9.7	29.7 32.8	24 28
	Forged and annealed at 650° C. for 1 hr.	7.5	29.10	22.5

There were many points of detail in the Paper which presented themselves for discussion. On page 5 the composition of the fourth alloy was given as 46.7/53.3.* This reversed the order in which the components of the other three alloys were given. On page 10 the author stated that he re-annealed his rolled ingots so as to restore them to their original "cast" Brinell hardness number. From experiments on the annealing of chill castings the writer had found that marked differences of hardness were obtained as between small ingots "as cast" and after cold-working and annealing. Had the author experienced the same thing, and did he endeavour to adjust the annealing conditions so as to obtain no further softening than represented by the hardness as cast?

On page 11 the author stated "1 per cent. of aluminium equalled approximately 5.6 per cent. of zinc in its effect on the general physical properties."

* Mr. Smalley has already corrected this.—Ed.

The writer would suggest that Mr. Smalley should make it quite clear that his figure 5.6 was really the co-efficient of equivalence, and that when substituted for 1 in the composition, made the total over 100, so that when the new percentage came to be worked out, it would be less than 5.6 for the apparent composition; it would, in fact, be nearer to the figure 4.

On page 19 the author stated that "exfoliation" of oxide would be encountered, if special precautions were not taken in the case of brass containing high manganese. Assuming the author's term "exfoliation" to mean the interpenetration of a tenacious oxidised skin with layers of the metal, a fault to which the writer had drawn attention in the Institute of Metals Paper already mentioned, he would draw attention to the ease with which this fault could be obviated by the addition of a very small quantity of aluminium—less than 0.25 per cent.

The author's claim for the grain-size reduction effected by iron fully confirmed the writer's own experience, but he was not prepared to accept the explanation offered by the author, that it was due to the nuclear action of insoluble particles of an iron-rich compound. Manganese was readily soluble in brass, but it effected a reduction of grain-size also, and the same explanation would not hold good for a metal which went entirely into solid solution. On page 38 the author referred to a manganese-rich constituent as being responsible for embrittlement and grain-size reduction.

The writer would be glad if evidence of the existence of this constituent could be provided, and also of the alleged desulphurising influence (p. 45).

The paragraphs on heat-treatment were extremely interesting. Could the author give the size of the test-pieces heat-treated, as he would be the first to recognise the profound influence of mass on the properties of heat-treated alloys?

Further evidence in favour of the solubility of N in brass would be welcomed, as, if this were established, it would be of profound scientific and industrial importance.

In conclusion, the writer desired to express his appreciation of the Paper and his hope that the value of it would become more widely known.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Loam Moulding in Liege.

To the Editor of THE FOUNDRY TRADE JOURNAL

SIR,—I was extremely interested in Mr. Varlet's Paper on loam moulding, and feel that somebody deprived the trade of useful information by limiting him in the way he states. Whilst it may be necessary to cut down some Papers, I think latitude should be allowed to foreign delegates. Perhaps a member of the Literary Committee will explain. Looking forward to further contributions from the pen of Mr. Varlet and congratulating the author on the excellence of his Paper, I am sir, yours, etc.,

"MAGPIE."

Newcastle.
September 26.

The Institution of Production Engineers.

Mr. Max. R. Lawrence, works manager of Messrs. The Sterling Telephone and Electric Company, Limited, Dagenham, Essex, has been re-elected as President of the Institution for the 1922-1923 session.

For the coming session papers have been arranged, the details of which will be announced shortly.

During February, however, a Paper on "Machine Moulding Methods" will be read by Mr. F. T. Hardyman, foundry manager to Messrs. Petters, Limited, Yeovil.

Local branches of the Institution have already been formed at Coventry and Newark-on-Trent, and it is hoped to inaugurate a local section at Glasgow during the coming session.

Trade Talk.

THE ASSETS OF the Waltham Engineering Company, Limited, including the works, are for sale.

THE IMPORTS of foreign iron ore at the Lonsdale Dock, Workington, last week amounted to 2,500 tons.

THE WORKS of the Bromford Spring Company, Queen Street, West Bromwich, have been seriously damaged by fire.

HALL & PICKLES, LIMITED, Port Street, Manchester, are opening a new office in the District Bank Chambers, Commercial Street, Halifax.

THE METROPOLITAN GALVANISING COMPANY, LIMITED, have removed their offices to the Osier Iron Works, Point Pleasant, Wandsworth, London, S.W.18.

A BRANCH of the Shipbuilding, Engineering and Steel Commercial Staffs' Association has been formed at Stafford, and Mr. H. Poole is its first chairman.

A FIRE occurred recently in the premises of Boynton, Dowsett & Company, engineers' tool makers, of Goswell Road, London, E.C., doing considerable damage.

B.R.C. FABRIC, made by the British Reinforced Concrete Engineering Company, Limited, Manchester, has been used for reinforcing the concrete road foundation in Piccadilly Circus.

IT IS NOW expected that the New Cransley furnaces, near Kettering, which have been closed down for the past sixteen months or more, will resume operations in the course of a week or so.

THE NUMBER of vessels launched in the Tyne from January 1 to August 31 was 26, of 88,999 total net register tons, as compared with 44 vessels of 130,128 tons in the corresponding period of last year.

LICENCES under the Non-Ferrous Metal Industry Act, 1918, have been granted to the Birchfield Foundry Company, Chain Walk, Birchfield, Birmingham, and H. F. Spencer & Company, Prudential Chambers, Wolverhampton.

THE INDIAN GOVERNMENT has sanctioned the electrification of a portion of the Bombay suburban lines of the Great Indian Peninsular Railway, the consulting engineers for which are Merz & McLellan, 32, Victoria Street, Westminster, London, S.W.1.

THE OPENING meeting of the Birmingham Metallurgical Society took place at the Chamber of Commerce Birmingham, on Wednesday, October 4, when the president, Mr. A. J. G. Smout, delivered his inaugural address on "Waste and Inefficiency in the Metal Industry."

THE ENGLISH ELECTRIC COMPANY, LIMITED, have been successful in obtaining a further contract amounting to £94,900 from the Preston Corporation, for the erection of the new super-generating station to be known as the Ribble Power Station. It may be recalled that the company are also supplying the large turbo-generating sets and condensers, etc., for this station. The English Electric Company, Limited, have decided to close down their Coventry works.

THE DEMAND for railway material in Colombia is likely to be heavy in the future. The National Government have to complete and equip the Pacific line, the Southern railway, the Northern railway, and the Tolima railway. The Antioquia railway will complete the line at "La Quiebra," the Amaga Railway Company propose going to the Cauca Valley, the Caldas railway from Pereira towards Manizales, the Puerto Wilches railway over 60 miles to Bucaramanga, and the Santa Marta Railway Company, Limited, the Magdalena river. The Department of Nariño propose starting its railway, and the lines from Ibague to Ambalema and Espinal to Neiva have not yet been completed.

THE DECISION of the Ebbw Vale Steel, Iron and Coal Company, Limited, to definitely close down their important Welsh undertaking indefinitely has now taken effect. This resolution followed a strike of the miners against the price lists embodied in what is known as the Galloway award. The greater part of the steel plant was already closed down because a strike of the coke-oven men had made it impossible to feed the furnaces. The remainder of the steelworkers were paid off on Friday. Energetic efforts are being made by local leaders to induce the company to reconsider their decision, and it has been arranged that a conference, which Sir John Beynon, deputy chairman of the Ebbw Vale Company, will attend, shall be held.

DR. H. M. VERNON, who has done invaluable work for the Industrial Fatigue Research Board, recently addressed the members of the third annual Industrial Welfare Conference at Balliol College, Oxford, on "The Importance of Keeping Records and Statistics." A system of efficient records and statistics is an integral part of the new ideas of industrial management which are steadily gaining ground. A good idea of the degree of ill-health in the workers, and its variations, could be obtained in keeping lost time records, especially if the time lost from sickness is separated from that due to other and avoidable causes. One of the chief causes of lost time lies in the accidents and injuries incurred. Hence an accurate record of all the accidents treated should be kept, and be examined statistically. The supervisor, continued Dr. Vernon, can best determine whether the workshop conditions are conducive to the maximum degree of health and efficiency in the workers by keeping exact records of the temperature of the workshops, and of the degree of ventilation. A large mass of information now exists as to the standards attained in the workshops of various industries, against which new results can be compared.

AN interesting scheme for the encouragement of thrift among the workers of an engineering firm was revealed by Mr. A. F. Ferguson, of Glenfield & Kennedy, Limited, at the third annual lecture conference organised by the Industrial Welfare Society. In these days, said Mr. Ferguson, remarkably few facilities are provided for saving small amounts. The Glenfield Welfare Savings Bank, started in September, 1919, has been an assured success. A few months ago there were more than 900 active accounts, while the weekly number of deposits and withdrawals averaged over 700. At the end of the last financial year the balance in favour of depositors was more than £9,000. Deposits are made in two ways, either by direct cash payment from 6d. upwards whenever convenient to a depositor, or for those who are able to save regularly and consistently, arrangements can be made for the transfer of stated amounts from wages to the credit of the depositors' account in the Works' Savings Bank. Withdrawals are made with as great facility as deposits are made. Seven days' notice is the rule, but in the majority of cases withdrawals are paid within a day or two of notice being given and urgent cases on demand. Interest is allowed at the rate of 4 per cent. per annum on each complete pound for each complete calendar month. In 1921, as the result of the success of the Welfare Saving Scheme, the directors suggested that the employés should be given an opportunity of investing savings in the company and took powers under the company's articles of association to accept loans on deposit from employés with rates of interest varying with the rates of dividend paid from time to time on the ordinary shares. Sums are received in multiples of £1, and the minimum rate of interest is 7½ per cent. subject to tax. This rate of interest is increased by ½ per cent. for each 1 per cent. beyond 10 per cent. distributed to the ordinary shareholders. At the present time the employés have a holding in the participating Loan Account amounting to nearly £30,000.

Formation of a Section of the Institute of Metals at Swansea.

THE PRESIDENT (Mr. Leonard Sumner), at the conclusion of the Swansea meeting, said there was one matter of importance to the Institute that he felt should be brought to the notice of the members. He referred to the possibility of the formation of a local section of the Institute. The present meeting appeared to have brought to a head an idea which had been in the minds of the Council for some time past, that the local members should express their wishes in regard to the formation of local sections. The matter had been voiced in several directions during the past few days, and he believed Prof. Edwards was now prepared to give his considered views on the subject.

PROF. C. A. EDWARDS said one of his chief wishes connected with the Institute holding a meeting at Swansea was that it might be the means of forming a local section in the district. He was very glad to say that after discussing the matter with a few of the more prominent members of the Institute and of the non-ferrous industries in the district they had definitely decided to take the necessary steps to form a local section of the Institute of Metals. It was hoped thereby to bring the district of Swansea more closely than had hitherto been the case in contact with the parent Institute, and it was further hoped it would be a means of encouraging other people in the district not only to take an interest in the work which was done locally, but also to become members of the Institute and help in the good work which it was carrying out.

The Institution of British Foundrymen.

A special general meeting of the members will be held at 4 p.m. on Saturday, October 7, at the College of Technology, Sackville Street, Manchester, for the following purposes:—(1) To approve the new by-laws prepared in connection with the Royal Charter; (2) election of senior vice-president; (3) place of next conference, 1923.

IRON AND STEEL MARKETS.

Pig-iron.

Conditions in the pig-iron industry, although showing some improvement, can hardly be regarded as entirely satisfactory, the continued slackness in such important consuming sections as founding and general engineering, still limiting production much below the average of normal times as far as home requirements are concerned. In the South Staffordshire area, for instance, only a proportion of the existing smelting plants are working, and, so far, there are no indications of additional furnaces going into blast in the near future. Here, however, it is satisfactory to note some improvement in demand for foundry iron both for light and heavy castings, but, on the other hand, the sale of forge quality leaves much to be desired, the recent slight improvement in inquiry for that description of pig not having been maintained. The continued stagnation in the manufacturing branches has, of course, an adverse effect upon pig-iron demand in the Midland centres of trade, where the export outlet is comparatively limited, and until a more general revival of business is established there can be little encouragement for increased production. Prices in the Birmingham market, however, remain firm, quotations for the principal brands being maintained at recent values The Scotch pig-iron market shows a diminution of recent activity in the export section, due to a slackening of the American inquiry, but in the meantime, ironmasters have full order books, and the tendency of prices continues firm. As regards home consumption on Clydeside, there is a slightly better outlook for the foundries turning out light castings, where orders are on a somewhat heavier scale than of late. There is also a better demand for steel-making pig, Scotch hematite remaining firm at 107s. 6d. per ton, with, however, the possibility of concessions in the case of substantial tonnages. In the Cleveland iron market, makers' stocks of No. 3 quality are almost exhausted, and last week supplies for prompt delivery were unobtainable. No. 1 is even scarcer than No. 3, and with No. 4 foundry now being drawn upon for export, No. 4 forge is the only description, with the exception of mottled and white, of which makers have a considerable amount on hand. With regard to No. 3, the September make is entirely sold out, and some makers are sold over the whole of October. The general quotation is now 95s., but it is possible to shade this figure for forward deliveries. Meanwhile, although sales in Scotland, as stated above, are reported to be rather better, home consumers are inclined to hold off in the expectation of lower prices as soon as the American demand is off the market. Pig-iron shipments this month look like being abnormally heavy. Boats were stemmed last week for 28,000 tons for the United States and Canada, the bulk of this being special foundry iron, and the remainder No. 3 and No. 4 The September shipments up to and including the 19th inst amounted to 22,683 tons, as compared with 16,265 tons in the corresponding period of August. Makers can now sell their current limited make at a good remunerative figure. No. 1 and silicious, for the very small quantities that come into the market, readily realise 97s. 6d., and 95s. is the general quotation for No. 3, though this figure can be shaded for forward shipment. No. 4 foundry has stiffened to 90s., but No. 4 forge is still obtainable at round about 85s., with mottled and white in the region of 82s. 6d. per ton.

Under the influence of a little more inquiry from America, together with rising coke prices, hematite quotations show a rather improving tendency. It is an altogether unprecedented position that hematite should actually be shillings cheaper than foundry iron. The demand from America, however, does not yet amount to very much, special analyses being mostly insisted upon. The home demand is still on the moderate side, but trade with the Continent, though small in volume, is steady. E.C. mixed numbers at last week's market were rather firmer at about 89s., with 6d. more for the No. 1 quality. On the North-West Coast the hematite market is firm, and indicates a tendency to better business. Bessemer mixed numbers are quoted at 100s. per ton delivered at Glasgow and Sheffield, and for export at 95s. per ton, f.o.b.

Finished Iron.

The near approach of the last quarter finds little prospect of immediate improvement in the various branches of the finished iron industry, which might encourage the promise of an early revival of general demand, indispensable if production is to be resumed on a profitable basis. Unfortunately, reports from the principal centres of manufacture point in quite the other direction, and all optimistic conjectures of renewed activity in the coming autumn appear likely to be disappointed. Prices are generally upheld by the high cost of production, but North-East Coast bar iron prices have reduced their prices by 10s. For a long time there has not been a reasonable profit on transactions. In South Staffordshire the industry is still suffering from the introduction of the eight hours shift, which, when all is said, does not give the volume of production necessary to average down costs. If the finished iron industry is to continue on any important scale, some steps will have to be taken to remove this defect. The marked bar trade is fairly steady, but good crown bars are in poor request. The price at which they are quoted is not attractive if the quality of the product is to be maintained. There is a moderate demand for small lots of bars of secondary quality and for fencing iron, the latter at £10 to £10 2s. 6d., but nut and bolt iron is still very quiet compared with what it was prior to the holiday. Conditions in the foundry branch are much the same as outlined in the case of finished material, the slow progress of returning activity in the engineering departments greatly retarding any general revival of demand for metal castings.

Steel.

Movements in most sections of the steel trade have been naturally affected by political conditions in the Near East, and export business has, in consequence, been on a more restricted scale during the past week, while the confirmation of the passing of the United States Tariff Bill has been a further factor in checking activity in placing orders for shipment across the Atlantic. As far as the ferro-alloy market is concerned, the effect of the tariff on this class of raw material remains to be seen, but works are still busy with a fair amount of business for ferro-manganese from the Continent, and more particularly Belgium. Prices remain unaltered, for both home and export trade. At Sheffield the improvement recently reported in the industry is maintained, but without further expansion of business. A fairly good market for mild steels is reported, and in this section there is now very slight competition from the Continent. A better inquiry is in circulation for crucible steel, and only now and again are Government surplus lots encountered. Supplies from this source must now be nearing exhaustion, for which producers will be thankful. A fair volume of business is coming forward for motor and railway steel. In South Wales the closing down of the Ebbw Vale Works must seriously affect the local steel trade, and should the negotiations between the firm and their employés fail in effecting an agreement of a stable character, the future outlook of the industry is most discouraging. The demand for steel and tinplate bars is very slack, and some of the works are becoming short of immediate specifications The Association price is unchanged at £7 7s. 6d. per ton. In soft steel billets very little new business has been done, and orders are difficult to obtain. Steel rails continue to be very quiet, and any business done has been confined to light sections for colliery purposes. A slightly better tendency iis apparent in the tinplate trade, but insufficient to influence any movement in values. If anything, forward quotations are inclined to ease, but generally makers declare that when their order books are exhausted they will close their works rather than reduce prices further. Spot plates are generally quoted at 19s. 3d. basis, but 19s. has been accepted for the last quarter.

Scrap.

Business in the scrap metal markets continues much the same as within the past few weeks; in some districts a little more active demand is being noted, while others remain dull and featureless. At Middlesbrough heavy steel scrap is in rather stronger demand. There is more inquiry from the works, and supplies to suitable specifications are not easily arranged. Consequently, the price has improved from recent values, and is now nearer 65s. than 62s. 6d., delivered works. Steel turnings and cast-iron borings are scarce, and now realise 50s. per ton, delivered. Business in other qualities is quiet at about the following delivered prices:—Heavy cast-iron machinery scrap, 70s.; heavy wrought iron bushelling scrap, 52s. 6d.; ditto, piling, 60s.; specially selected heavy forge, 70s. to 75s. per ton.

XUM

Metals.

Copper.—Movements in the standard copper market last week showed some weakening in values, operators being reluctant to commit themselves pending developments in the Near East crisis. The settlement of the industrial disputes in the U.S.A. has been the only satisfactory feature during a period in which political crises have succeeded each other in bewildering rapidity. Electrolytic copper has lately been held firmly in America, but sales have been reported at a shade a little under 14 cents. An increasing volume of business has been passing in refined copper in this country, but Continental inquiry has fallen off for the time being. Current quotations :—Cash : Wednesday, £62 12s. 6d.; Thursday, £62 12s. 6d.; Friday, £62 17s. 6d.; Monday, £63 5s.; Tuesday, £63 2s. 6d. *Three Months* : Wednesday, £63 5s.; Thursday, £63 5s.; Friday, £63 7s. 6d.; Monday, £63 15s.; Tuesday, £63 15s.

Tin.—The uncertainty of the political situation has had only a modified effect upon business in standard tin, and values, though somewhat disturbed, have fluctuated within a comparatively narrow range. The East has sold steadily at small premiums over standard, the total for the past week being 900 tons. Banca and Chinese are being held for a higher market, and English common is commanding relatively full prices. Operations in standard tin have been influenced to some extent by the political outlook, but fluctuations have not been wide. Owing to more free lending of warrants, the contango on three months has increased to 25s. per ton. The practical settlement of industrial troubles in the United States has coincided with increased purchases of tin in New York, and the prospects for active consumption there are improved. The output of American tinplate mills is now roughly 40 per cent. in excess of the 1914 production. Current quotations :—*Cash* : Wednesday, £159; Thursday, £160 10s.; Friday, £161; Monday, £161 10s.; Tuesday, £161 5s. *Three Months* : Wednesday, £160 5s.; Thursday, £161 15s.; Friday, £162 5s.; Monday, £162 15s.; Tuesday, £162 10s.

Spelter.—Inquiry for this metal of late has been only on a moderate scale, and values have weakened to a small extent. On the other hand, in America, the market is distinctly strong. Stocks have been heavily drawn upon, and there the price-level is high above the parity of values ruling here. Reports from Scandinavia speak of a better demand, and of the small chance of metal being available for export. Current quotations :—*Ordinary* : Wednesday, £31 12s. 6d.; Thursday, £31 17s. 6d.; Friday, £32 5s.; Monday, £32 7s. 6d.; Tuesday, £32 5s.

Lead.—The market for soft foreign pig continues quiet and steady, with an easier tendency in the prompt position. While Mexican shipments to Europe may be augmented during the next few months, owing to the new tariff imposed in the U.S.A., production in Spain and Australia does not at the present moment appear to be increasing. Current quotations :—*Soft foreign (prompt)* : Wednesday, £24 5s.; Thursday, £24 5s.; Friday, £23 15s.; Monday, £24; Tuesday, £23 18s. 9d.

Company News.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Interim dividend on ordinary, 6d. per share, less tax.

National Engineering Company, Limited, 1, West Bute Street, Cardiff.—Capital £10,000 in £1 shares. Director: P. C. Phillips.

Bruce Peebles & Company, Limited.—Dividend, 7½ per cent. per annum, less tax, on 7½ per cent. cumulative participating preference shares.

G. Haslam & Company, Limited, 51, Broadway, Leigh-on-Sea.—Engineers. Capital £2,000 in £1 shares. Directors: G. S. Haslam and W. G. Haslam.

Fredk. Mountford (Birmingham), Limited, 38, Moseley Street, Birmingham.—Engineers. Capital £10,000 in £1 shares. Director: F. Mountford.

Central Foundry Company, Limited, 46, Furnace Hill, Sheffield.—Capital £5,000 in £1 shares. Directors: J. Abson, F. B. Abson and F. Chamberlain.

Great West Engineering Company, Limited, Park House, Boston Road, Brentford.—Capital £3,000. Directors: O. M. Shepherd, G. W. and N. C. Stephenson.

Howard Pneumatic Engineering Company, Limited.—Capital £13,000 in £1 shares. Directors: S. E. Thornton, A. Howard, S. M. J. Nugent and P. C. Bird.

Lovetts, Limited, 418, Romford Road, Forest Gate, E.—Engineers. Capital £12,000 in £1 shares. Directors: C. E. Lovett, H. R. Bleesby, and R. R. Wilkins.

Albert E. Hargreaves, Limited, 124-6, Mornington Road, Bolton, Lancs.—Engineers. Capital £3,000 in £1 shares. Directors: A. E. Hargreaves, E. Hargreaves, H. Haughton and A. Jonas.

Stothert & Pitt, Limited.—Profit, £28,658; brought forward, £5,153; total, £33,811; final ordinary dividend, 7½ per cent., free of tax, making 12½ per cent., free of tax, for year; carry forward, £7,020.

Steel Company of Scotland, Limited.—Dividend, 12½ per cent., less tax, for year; depreciation of steel works' plant, £40,000; depreciation of collieries, dwelling-houses and lands, £7,600; reserve, £25,000; carried forward £160,058.

Gazette.

MESSRS. G. B. VICKERS & J. H. BAKER, engineers, 94, Worsley Road, Patricroft, Manchester, trading under the style of Vickers, Baker & Company, have dissolved partnership.

NORTH SOMERSET ENGINEERING COMPANY, LIMITED.—It has been resolved that the company be wound up voluntarily. Mr. D. Owen, 47, Milsom Street, Bath, C.A., has been appointed liquidator.

SIMOON ENGINEERING COMPANY, LIMITED (late Julien and Grebert Engineering Company, Limited), London, W.C., in liquidation. Mr. H. C. Chambers, 5, Chancery Lane, W.C., C.A., has been appointed receiver.

MESSRS. J. C. FERGUSSON AND H. WALKER, civil and mechanical engineers, 7, Gloucester Square, Southampton, trading under the style of the British East Africa and Uganda Settlers' Agents, have dissolved partnership.

TRADING IN THE STYLE of Abernethy & Company, Messrs. T. C. Storey, W. Abernethy & R. Macdonald, 40, Brand Street, Lorne Square, Govan, Glasgow, blacksmiths, general engineers and sheet-iron workers, have dissolved partnership. Debts by Messrs. W. Abernethy and R. Macdonald, who continue the business as Abernethy & Macdonald.

Contracts Open.

Bangkok, January 31.—Stores, for the Siam State Railways. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Bridgend, October 2.—Providing and laying about 107 lin. yards of 4-in. and 442 lin. yards of 3-in. diameter cast-iron mains, etc., for the Mid-Glamorgan Water Board. Mr. E. W. Davies, superintendent and manager, Water Board Offices, Bridgend. (Fee, £1 1s., returnable.)

Cachoeira, Brazil, October 24.—The municipality of Cachoeira require six centrifugal pumps with electric motors, cast-iron and galvanised iron piping, cement and earthenware piping, etc, in connection with the sewerage system of the town of Cachoeira. The Municipal Public Works Office.

Personal.

THE LATE Mr. James Primrose, sole partner of Primrose & Company, ironfounders, Leith, left £23,047.

THE LATE MR. A. H. SHENTON, of "The Grange," Little Sutton, Sutton Coldfield, ironmaster, left estate of the gross value of £3,723.

MR. J. CAUTHERY has resigned his position as chief engineer to the Spearing Boiler Company, Limited, 20, Kingsway, London, W.C.2.

THE LATE Mr. J. M. Draper, a director of the Rhondda Engineering & Mining Company, Limited, the Manchester Minerals Tributes, Limited, and Sheppard & Sons, Limited, left £5,138.

MR. WILLIAM SMITH, chairman and managing director of Thomas Smith & Sons, of Saltley, Limited, drop forgers, who died on June 23, left estate of the gross value of £64,318, with net personalty £63,589.

Publications Received.

CONSETT IRON COMPANY, LIMITED, Consett, Co. Durham. Price list of silica and firebricks for September.

THE DECIMAL EDUCATOR, published by the Decimal Association, Finsbury Pavement House, E.C. 2., price 6d. The current number of the "Decimal Educator" contains the inaugural address of the President, Sir Richard Gregory.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

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Phoenix Works, Penistone NEAR SHEFFIELD.

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PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

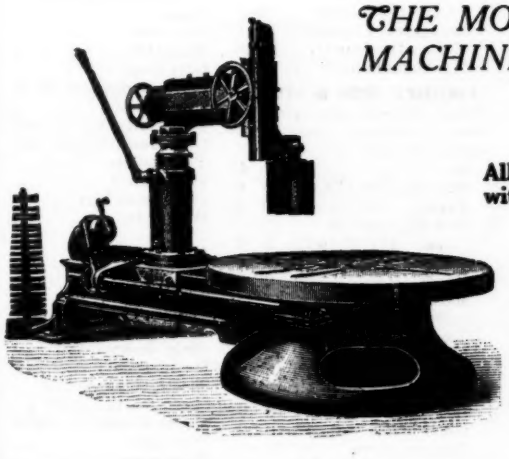
FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 feet diameter can be made.



THE MOST COMPLETE & EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WILLIAM WHITTAKER & SONS, Ltd.

SUN IRON WORKS - - - OLDHAM.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	63	2	6
Three months	63	15	0
Electrolytic	71	5	0
Tough	66	0	0
Best selected	66	0	0
Sheets	94	0	0
India	84	0	0
Wire bars	71	5	0
Do. Oct.	71	5	0
Do. Nov.	71	0	0
Ingot bars	71	0	0
H.C. wire rods	76	7	6
Off. aver. cash, Aug.	63	16	9 2/11
Do. 3 mths., Aug.	63	19	2 5/11
Do. Settlement Aug.	63	16	11 2/11
Do. Electro, Aug.	70	8	7 7/11
Do. B.S., Aug.	67	6	8
Aver. spot price, copper, Aug.	63	16	1½
Do. Electro, Aug.	70	18	7½

Solid drawn tubes 13½d.
Brazed tubes 13½d.
Wire 10½d.
Yellow metal rods 6½d.
Do. 4x4 Squares 8½d.
Do. 4x3 Sheets 9½d.

BRASS.

Solid drawn tubes 11½d.
Brazed tubes 13½d.
Rods, drawn 10½d.
Rods, extruded or rolled 6½d.
Sheets to 10 w.g. 10d.
Wire 9½d.
Rolled metal 9½d.

TIN.

	£	s.	d.
Standard cash	161	5	0
Three Months	162	10	0
English	161	5	0
Bars	163	5	0
Chinese		—	
Straits	161	17	6
Australian	161	15	0
Eastern	164	2	6
Banca	161	12	6
Off. aver. cash, Aug.	160	1	0 3/11
Do. 3 mths., Aug.	160	3	4 10/11
Do. Settlment. Aug.	160	1	7 1/11
Aver. spot, Aug.	160	0	5½

SPELTER.

	£	s.	d.
Ordinary	32	5	0
Remelted	30	10	0
Hard	24	10	0
Electro 99.9	34	10	0
English	32	5	0
India	25	7	6
Prime Western	32	10	0
Zinc dust	48	0	0
Zinc ashes	10	10	0
Off. aver., Aug.	30	16	3
Aver., spot, Aug.	31	3	5

LEAD.

	£	s.	d.
Soft foreign ppt	23	18	9
English	25	5	0
Off. average, Aug.	24	3	10 4/11
Average spot, Aug.	24	11	8½

ZINC SHEETS.

	£	s.	d.
Zinc sheets, English	37	10	0
Do. V.M. ex. whf.	38	10	0
Dutch	38	0	0
Rods	42	0	0
Boiler plates	35	10	0
Battery plates	36	0	0

ANTIMONY.

	£	s.	d.
English regulus	28	15	0
Special brands	32	10	0
Chinese	23	10	0
Crude	15	0	0

QUICKSILVER.

Quicksilver 13 7 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon — 50/60%	12	2	6
75%	20	15	0

Ferro-vanadium— 35/40% 17/3 lb. va.
Ferro-molybdenum— 70/75% 8/6 lb. mo.
Ferro-titanium— 23/25%, carbonless 1/1 lb.
Ferro-phosphorus, 20/23%, £27
Ferro-tungsten— 80/85%, carbon free 1/5½ lb.
Tungsten metal powder— 98/99% 2/- lb.

Ferro-chrome—

4/6% car.	£23 0
6/8% car.	£22 12 6
8/10% car.	£22 5

Ferro-chrome—

Max. 2% car.	£55
Max. 1% car.	£68
Max. 0.70% car.	£75
67/70%, carbonless	1/6½ lb.

Nickel—99%, cubes or pellets £145
Cobalt metal—98/99% 12/- lb.
Aluminium—98/99% £100
Metallic Chromium— 96/98% 5/- lb.

Ferro-manganese (net)—

76/80%, loose	£15
76/80%, packed	£16
76/80%, export	£14 10

Metallic manganese— 94/96%, carbonless 2/4 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten s. d. 2 6
Finished bars, 18% tungsten 3 0
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ½ in. to ¼ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d. lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d
Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales— Heavy Steel	3	7	6	3	12	6
Bundled steel & shearings	2	17	0	3	5	0
Mixed iron & steel	2	17	6	3	2	6
Heavy cast iron	3	5	0	3	15	0
Good machinery for foundries	4	0	0			
Cleveland— Heavy steel	3	5	0			
Steel turnings	2	10	0			
Cast-iron borings	2	10	0			
Heavy forge	3	12	6			
Bushelled scrap	2	12	6			
Cast-iron scrap	3	10	0			
Lancashire— Cast iron scrap	3	17	6			
Heavy wrought	3	7	6			
Steel turnings	2	2	6			

London—	£	s.	d.
Copper (clean)	56	0	0
Brass (clean)	30	0	0
Lead (less usual draft)	20	0	0
Tea lead	17	0	0
Zinc	17	0	0
New aluminium cuttings	60	0	0
Braziery copper	46	0	0
Gun metal	40	0	0
Hollow pewter	125	0	0
Shaped black pewter	80	0	0

Above are merchant's buying prices delivered yard.

PIG-IRON.

N. E. Coast— Foundry No. 1	97 6
Foundry No. 3	95/-
Forge No. 4	85/-
Mottled	82/6
Hematite No. 1	89/6
Hematite M/Nos.	89/-
Midlands— Staffs. common	—
„ part-mine forge	—
„ „ foundry	—
„ Cold blast	240/-
„ basic	—
Northants forge	70/- to 72/6
„ foundry No. 3	77/6 „ 80/-
„ basic	82/6
Derbyshire forge	75/-
„ foundry No. 3	82/6
„ basic	80/-
Scotland— Foundry No. 1	106/6
„ No. 3	101/6
Hematite M/Nos.	107/6
Sheffield (d/d district)— Derby forge	82/6
„ foundry No. 3	86/6
„ basic	—
Lincs. forge	86/6
„ foundry No. 3	86/6
„ basic	86/6
E.C. hematite	100/-
W.C. hematite	102/6

All d/d in the district.

Lancashire (d/d eq. Man.)— Derby forge	—
„ foundry No. 3	90/-
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Summerlee foundry	116/6
Glengarnock foundry	118/6
Gartsherrie foundry	118/6
Monkland foundry	116/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	£10 15 to 11	10	0
Angles	£11 5 to 11	10	0
Tees to 3 united ins.	£11 15 to 12	5	0
Nut and bolt	9	17	6
Hoops	14	0	0
Marked bars (Staffs.)	13	10	0
Gas strip	11	0	0
Bolts and nuts, ½ in. × 4 in.	18	10	0
Steel— Ship plates	£9 to 9	10	0
Boiler plates	12	10	0
Chequer plates	10	10	0
Angles	£8 12 6 to 9	0	0
Tee	£9 12 6 to 10	0	0
Channels	8	10	0
Joists	9	0	0
Rounds & squares 3-in. to 5½in.	9	15	0
Rounds, under 3in. to ½in.	9	5	0
Flats, over 5in. wide and up	9	15	0
Flats 5in. to 1½in.	8	5	0
Rails, heavy	8	15	0
Fishplates	14	10	0
Hoops	11	10	0
Black sheets, 24 g.	12	0	0
Galv. cor. sheets, 24 g.	46	10	0
Galv. fencing wire, 8 g. plain	16	0	0
Rivets, ½ in. dia	12	15	0
Billets, soft	7 0 0 to 7	2	6
Billets, hard	8	0	0
Sheet bar	6 17 6 to 7	7	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
CHARLES CLIFFORD & SON LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	11d. to 1/5
Rolled— To 9 in. wide	1/5 to 1/11
To 12 in. wide	1/5½ to 1/11½
To 15 in. wide	1/6 to 2/0
To 18 in. wide	1/6½ to 2/0½
To 21 in. wide	1/7½ to 2/1½
To 25 in. wide	1/8½ to 2/2½
Ingots for spoons and forks	11d. to 1/5
Ingots rolled to spoon size	1/2 to 1/8
Wire round— 3/0 to 10. G.	1/8½ to 2/3

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	34.64
No. 2 foundry Valley	35.00
No. 2 foundry, Birm.	25.00
Basic	34.46
Bessemer	24.76
Malleable	34.96
Grey forge	36.76
Ferro-manganese 80 % delivered	75 00
Bess. rails, h'y, at mill	40.00
O.-h. rails, h'y, at mill	40.00
Bess. billets	40.00
O.-h. billets	40.00
O.-h. sheet bars	40.00
Wire rods	47.50
	Cents.
Iron bars, Phila.	2.57
Steel bars	2.10
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.60
Plain wire	2.35
Barbed wire, galv.	3.15
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry 35/- to 40/-
„ furnace 30/- to 32/6
Durham & North foundry 28/-
„ furnace 23/6
Other Districts, foundry 27/6
„ furnace 22/-

SWEDISH IRON.

Bars, hammered basis sizes Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	17 0 0 to
Nail Rods—Square, round and flats ..	17 10 0

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded £13 to £14

Pig-Iron—
Grey, white or mottled .. £7 to £7 10 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas	.. 55%	Tube prices are now free.
Water	.. 50%	
Steam	.. 45%	

TINPLATES.

I.C.Cokes,	20×14, box	19/1½
,,	28×20, ,,	38/3
,,	20×10, ,,	28/3
,,	18¾×14, ,,	19/6
I.X.	,	44/-
I.X.X.	,,	51/-
F.C.B.Y.	21×13⅝ ,,	37/-
C.V.B.G.	16¾×15, ,,	35/6
I.C.W.	20×14, ,,	16 10½
,,	28×20, ,,	33/6
,,	20×10, ,,	23/3
,,	18¾×14, ,,	17/3
Ternepiates,	28×20, ,,	25/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.	
Sept.20	62	12	6	No change
,, 21	62	12	6	,,
,, 22	62	17	6	inc. 5/-
,, 25	63	5	0	,, 7/6
,, 26	63	2	6	dec. 2/6

Electrolytic Copper.

Sept.20	71	7	6	dec. 2/6
,, 21	71	2	6	,, 5/-
,, 22	71	2	6	No change
,, 25	71	5	0	inc. 2/6
,, 26	71	5	0	No change

Standard Tin (cash).

Sept.20	159	0	0	inc. 5/-
,, 21	160	10	0	inc. 30/-
,, 22	161	0	0	,, 10/-
,, 25	161	10	0	,, 10/-
,, 26	161	5	0	dec. 5/-

Tin (English ingots)

Sept.20	158	10	0	inc. 5/-
,, 21	160	0	0	inc. 30/-
,, 22	161	0	0	No change
,, 25	161	10	0	inc. 10/-
,, 26	161	5	0	dec. 5/-

Zinc Sheets (English).

Sept.20	37	10	0	No change
,, 21	37	10	0	,,
,, 22	37	10	0	,,
,, 25	37	10	0	,,
,, 26	37	10	0	,,

Spelter (ordinary).

Sept.20	31	12	6	No change
,, 21	31	17	6	inc. 5/-
,, 22	32	5	0	,, 7/6
,, 25	32	7	6	,, 2/6
,, 26	32	5	0	dec. 2/6

Lead (English)

Sept.20	25	5	0	No change
,, 21	25	5	0	,,
,, 22	25	5	0	,,
,, 25	25	5	0	,,
,, 26	25	5	0	,,

THE
ARMITAGE WORKS Co., Ltd.
Manufacturers of
Highly Refractory Bricks and Blocks
FOR ALL PURPOSES.

SPECIALITIES:
CUPOLA LININGS.
Ladle Bricks for Siemens Ladles.
Chequer Bricks, etc., for Siemens Furnaces.
Gas Producer Linings.

GROUND GANISTER
for Iron, Steel, and Brass Furnaces. Forced Draught Brass Furnaces. Semi-Silica or Semi-Ganister Bricks. Silica Cement.

DEEPCAR, Near Sheffield.

SHROPSHIRE IRON Co., Ltd.

Works:—
Hadley, Shropshire.

London: 10, Bush Lane, Cannon St., E.C.4.

Telegrams:—
Sun, Wellington, Salop.
Sunbrand (Cannon), London.

Telephone:—
11 Wellington, Salop.
5959 Central.

BARS, HOOPS, SECTIONS & WIRE
in IRON, STEEL, COPPER and BRONZE.
Galvanised Telegraph, Telephone, Cable and Trolley Wire
To all Specifications.

Contractors to H.M. Government (Admiralty, G.P.O., India Office, War Office, Colonies), English and Foreign Railways, &c.

BEST H. C. COPPER & BRONZE WIRE a speciality.

Medals:—Sydney (Bronze) 1879, New Zealand (Gold) 1882, Liverpool (Silver) 1886, Adelaide (Gold) 1887, France-British Grand Prix (Highest Award) 1908.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT
5, MURZBAN ROAD, BOMBAY.
1, LALL BAZAR CALCUTTA.

REGISTERED TRADE MARK

1, HONG KONG ROAD, SHANGHAI
31, RAFFLES PLACE, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5 SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.

PIG IRON
SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.
IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

MOULDER REQUIRES STEADY AND PROGRESSIVE JOB. Accustomed to complete control. Motor and General Engineer and Jobbing. Personally operating Cupola and other Furnaces, making oil-sand jacket cores, and supplying castings to analysis. Iron, Aluminium and Bronze. Good Technical and Practical: Mathematics, Mechanics, Chemistry, Physics, Metallurgy, Iron and Steel Manager and Mechanical Drawing. Good knowledge of costs, and could assist in Drawing Office, Pattern Shop or any department of Foundry. I.B.F. and B.C.I.R.A. Man. — Apply: F. A., c/o Ignition Laboratory, 57, Union Street, Oldham, Lancs.

ADVERTISER desires Position, where experience and ability is required, as Foundry Foreman or Manager; 19 years' practical and technical training all branches iron and non-ferrous work; 9 years as Foreman and Manager. Experience on Motor, Engineering and Jobbing Work up to 20 tons. Expert on Cupola, mix metals by analysis, knowledge of metallurgy; good organiser, tactful with labour. Guarantee consistent results. McLain and I.C.S. graduate.—Box 264, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

FOUNDRY MANAGER or Assistant, age 38, experienced Steam and Motor Cylinders, Pumps, etc., Quantity Production, desires Engagement. Patterns, Moulding Equipment, Mixing by Analysis, Cupola Practice, extensive Experience of Oil Sand Cores, Core Jigging, modern Core- and Mould-drying Stoves. Knowledge costing and estimating. A.M.I.Brit.F.—Replies, Box 268, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

UNDER FOREMAN MOULDER Wanted for Steel Foundry in Yorkshire; castings up to 5 tons each; capacity 100 tons weekyl.—State experience, wage, and full particulars, to Box 258, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

ENGINEER wanted to take charge under Chief Engineer of Blast Furnace Plant, and Pipe and General Foundries, also Drawing Office control and Estimating Department on North-East Coast. Applicants must be between the age of 32/40, and state experience and salary required. None but energetic men need apply.—Apply, Box 266, Offices of THE FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2

TENDER

GALVANISED Iron or Steel Tubular Poles for Telegraph Poles, 20 ft. long, 1,500, Schedule 755. Tenders are invited by the Commonwealth of Australia for the above, receivable in Australia on 15th November.—For tender, forms, and full particulars, apply SUPPLY OFFICER, Room 101, Australia House, Strand, London, W.C.2.

AGENCIES.

SOLE AGENTS required in all industrial districts in Great Britain, and also for Foreign and Colonial Countries, for an entirely new Foundry Product, which is now being used by some of the leading foundries with every satisfaction; time saving and efficiency in its use; splendid opportunity for live firms. State district.—Write Box 260, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY.

FOR SALE.

Three 75 B.H.P. D.C. Shunt Wound Motors, by Vickers, 440 volts, 600 revs., with pulley, etc. Two 60 B.H.P. D.C. Shunt Wound Motors, by Vickers, 440 volts, 630 revs. Six 40 B.H.P. D.C. Shunt Wound Motors, by Vickers, 440 volts, 600 revs., with pulley and slide rails. Worthington Horizontal Duplex Pump, 14 in. x 12 in. x 10 in., 10 in. suction, 8 in. delivery. Horizontal boring machine, by the Lucas Machine Tool Company, 3 in. spindle, T-slotted table, 3 ft. 6 in. x 1 ft. 10 in. 350 K.W. Generating Set, by Scott & Mountain, 3-crank compound engine, direct coupled to generator, 230 volts, 350 revs. 250 K.W. Generating Set, by Bellis & Morcom, triple expansion engine, direct coupled to generator, 460/550 volts, 380 revs. 100 B.H.P. Gas Engine, magneto ignition, 16½ in. cylinder, 24 in. stroke, by Bates & Company. 14 B.H.P. Oil Engine, pair of cylinders 6½ in. diam., 7 in. stroke, by the Torbinia Engineering Company, Limited. Vertical Compaund Steam Vacuum Pump, steam cylinders 6 in. and 12 in. diam., and cylinders 17 in. diam., 8 in. stroke, capacity 1,000 cub. ft. free air per min.

Catalogue of Stock Machinery, 5-6,000 Lots. Free on Application. Inspection Invited.

THOS. W. WARD, LTD.,
ALBION WORKS,
SHEFFIELD.

MACHINERY.—*Contd.*

NEW WELDING PLANT, with Acetylene Generator, six blowpipes, etc., ready for use, £17 5s.; complete new Cutting Plant, £15 10s. Lists free.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

ONE 20-in. CENTRIFUGAL FOUNDRY SAND MIXER, capacity 1 to 2 tons per hour, fitted with latest improvements and equal to new.—Price and particulars on application to C. E. V. HALL, 26, Paradise Square, Sheffield.

FOUNDRY SAND MIXERS (three), never been used, for 1, 2 and 4 tons per hour; clearance prices.—Box 158, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

CUPOLAS! CUPOLAS!! CUPOLAS!!!—Fifteen Riveted Steel Cylinders, as new, 18 ft. x 2 ft. 6 in.; would make excellent Cupolas, complete with Steel Girder Framework Pipes and Air Ducts; £300 the lot, f.o.r. Details, Drawings.—HARRY H. GARDAM & COMPANY, LIMITED, Staines.

WANTED, small Moulding Machine, hand or power, to handle boxes about 20 in. x 14 in. Jolt Ramming Machine, plain or with turnover table, to take boxes 3 ft. 6 in. square, 20 in. deep.—Box 262, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—One Foundry Ladle only, 10 cwts. capacity, and complete with slings.—Reply, Box 252, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2

PATENTS.

ADVICE and Handbook Free.—KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

THE Proprietor of British Patent No. 147,925, dated September 11, 1918, relating to Improvements in Pair-heating-Furnace Hearth, is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain. All inquiries to be addressed to MR. B. SINGER, Woolworth Building, New York City, N.Y., U.S.A

PROPERTY.

FOR SALE.—FREEHOLD FOUNDRY (Ferrous and Non-Ferrous).—Apply, E. T. PEIRSON & SONS, Chartered Accountants, Coventry.

FOUNDRY BUSINESS FOR SALE by private treaty (owing to the retirement of the owner). An old-established Foundry and Engineering Business in an important Midland town, including the Freehold Premises, Goodwill, Machinery and Stock-in-Trade.—For further particulars, apply to E. IRWIN MILLER, Esq., Solicitor, Bridge Street, Walsall.

MISCELLANEOUS

NORTHANTS (B.508).—Company Manufacturing Builders, goods and light castings, requires Partner thoroughly conversant with Foundry Work to invest £3,000 to £5,000, and take entire control. Abundance of work in hand.—Apply, HENRY BUTCHER & COMPANY, 63 and 64, Chancery Lane, London, W.C.2.

PENCIL GANISTER, of high quality, and other grades for Sale.—Apply, R. E. ADAMSON, Ushaw Moor, County Durham.

MOULDING BOXES

IN STOCK HERE for immediate delivery.

Quantity.	Size (inside).	Depth top.	Depth bottom.	Description.	Price per pair.
60 pairs	12" ×12"	4"	4"	Plain cast-iron with straight sides.	9/-
40 pairs	16" ×14"	4½"	4½"	Taper sides, C.I. ..	16 -
200 pairs	16" ×14"	4½"	4"	Straight sides, C.I.	12/6
150 pairs	18" ×18"	5"	5"	Taper sides, C.I. ..	16/-
60 pairs	15½" ×15½"	5"	5"	Taper sides, C.I. ..	14/-
200 pairs	18" ×12"	4"	4"	Straight sides, C.I.	12/6
50 pairs	18" ×12"	4"	4"	Pressed steel, by Macdonald.	15/-
60 pairs	16" ×10"	4"	4"	Pressed steel, by Macdonald.	12/6
4 pairs	42" ×42"	5½"	8"	New boxes, with crane swivels.	£9
25 pairs	20" dia.	4"	9"	All these are interchangeable	£1
30 pairs	20" dia.	9"	4"		£1
40 pairs	20" dia.	4"	4"		16/-

These boxes are all interchangeable, all in first-class order, practically new, suitable for use on machines or for handwork.

Where the whole of any one size is taken, I allow a special discount of **12½ per cent.**

In addition to the above, I have a **Large Stock** of all kinds of Jobbing Boxes, all sizes, also Box Trestles, Core Racks, Core Stoves and Doors for building same: Shanks, Ladles, Moulding Machines, and Foundry Plant and materials of all descriptions.

ALEX. HAMMOND, Foundry Machinery Merchant, BOXTED : : SLOUGH

Phone: 287 SLOUGH. Wire: "HAMMOND, BOXTED, SLOUGH."